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Energy consumption pattern of the people

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Abstract

This study investigates energy consumption patterns among selected respondents in urban and rural areas. Key findings regarding the personal and socio-economic profile reveal that the majority of respondents in both urban and rural areas belong to the middle-age group. Family structures differed significantly, with urban areas showing a prevalence of nuclear families i.e. 51 per cent and rural areas exclusively joint families i.e. 100 per cent.

Regarding energy consumption patterns, urban respondents primarily used bikes, cars and scooties fuelled by petrol, diesel and CNG, while rural areas predominantly relied on petrol for bikes. Electricity, petrol and LPG were widely used in both settings, with petrol being the most relied-upon fuel, followed by electricity. Expenditure patterns showed urban respondents spending most on electricity, while rural respondents' highest expenditure was on diesel. Advanced equipment usage was common in urban areas but limited in rural areas, with most equipment in both regions being used daily and powered by electricity for long durations. Both urban and rural respondents used fuel energy at home, with rural areas reporting 25-30 kW power usage. All respondents reported good access to electricity. Awareness of government schemes was high in both groups. While urban respondents had no plans for solar panel installation, rural respondents did. Urban respondents perceived energy costs as a burden, whereas rural respondents did not. Interest in learning about energy-efficient farming methods was high in urban areas but low in rural areas.

Keywords: Energy consumption pattern, urban and rural households, fuel usage

Introduction

India is a major energy consumer, ranking third globally, driven by a growing economy, population and industrialization. While per capita energy consumption remains below the global average, India's overall energy demand is substantial and growing, with coal being the dominant energy source for power generation, although its share is gradually decreasing. The country relies heavily on imports for oil and natural gas. India is also actively increasing its renewable energy capacity, particularly in solar and wind power, which currently contribute around 30 per cent to the total installed capacity.

While the country has achieved near-universal household access to electricity, affordability and reliability of energy supply remain key concerns. Industries, households and agriculture are the major consumers of electricity in India, with industries accounting for the largest share. India's energy sector is expected to see significant changes, with a growing focus on renewable energy, energy efficiency and sustainable development. Renewable energy sources, particularly solar and wind, are experiencing rapid growth and now contribute approximately 30 per cent to India's installed capacity.

India has set ambitious goals for renewable energy capacity (500 GW by 2030) and net-zero carbon emissions

(2070). Energy consumption at household level may impact this ambitious goal. Renewable energy might be a solution to reduce energy consumption at household level. Hence, the present study was planned to study the energy consumption pattern at household level in rural and urban areas of Gujarat.

Review of literature

The increasing world demand for oil, leads to frequent escalation in the world oil prices. Like shortage of oil, there was also shortage of electricity and other forms of energies viz. natural gas. The shortage could significantly affect the consumption and production in the economy (Sahu, 2008) [1].

Stankuniene (2021) [2] analysed that the possibility to pay for energy savings was closely related to the owners' income and household owners were often spending more on the most visible (e.g., aesthetic) but non-energy investment benefits.

Sani *et al.* (2024) [3] stated that rural households were predominantly dependent on traditional cooking energy sources like charcoal, firewood, and agricultural residues, while urban households had higher consumption of gas and electricity.

Shahi conducted a study in Nepal and collected data from

442 households in three regions of Nepal i.e., Kalikot (a rural area), Chitwan (a semi-urban area) and Kathmandu (an urban area). He reported that the electricity was used only for lighting purposes in the rural area, but other electrical appliances were used in semi-urban and urban areas. The amount of electricity use had not affected by household income level in the rural area, but it had affected in semi-urban and urban areas. The level of education affected the use of the LED significantly.

Jangali and Nagesha (2018) ^[5] found that the annual LPG consumption was more compared to the annual electricity usage in Davangere city, Karnataka. About 54 per cent of energy was shared by the LPG and 46 per cent was shared by electricity in all residential buildings. The share of the LPG was more in the residential sector because most of the energy used in this sector was for cooking purpose. The electricity was required for the equipment like Television, refrigerator, washing machine, mixer, lighting, etc., which could be considered as secondary need, but LPG was the prime requirement in every urban household for cooking purpose. In some households, the LPG was also used for gas geysers to provide hot water for bath.

The findings of Ren and Zhujun (2017) ^[6] shows that fuelwood was the most commonly used fuel in rural areas for cooking although some economically developed rural areas employed natural gas. Mostly rural residents use coal for heating in winter season while residents of cities primarily employed electricity. Further, the researchers stated that combustion of fuelwood and coal poses severe threat to the environment and rural residents' health.

Zhao *et al.* (2012) ^[7] reported that there was an unobvious difference of per capita energy consumption between areas. In terms of energy structure, urban households were dominated by the fossil energy, while rural households were dominated by both of biomass energy and fossil fuels. The emissions of rural households were much larger than those of urban households. Both population size and income factors had promoting effect on total energy and the ecological footprints of electricity and coal etc. in urban areas and electricity and biomass in rural areas.

The findings of a study conducted by Blooshi *et al.* (2019) ^[8] revealed that more than 50 per cent of the participants agreed that climate change was controlling their energy and water consumption pattern.

Geoffrey and Kelvin (2001) ^[9] found the influence of weather and cooking style on energy consumption distribution and the daily energy loading patterns. Significant factors influencing electricity energy consumption included flat size, household income, number of household members and ownership of air-conditioners, clothes dryers, rangehoods and ventilation fans in the summer. On the other hand, factors like housing type, number of household members, and ownership of electric water heaters and rangehoods were major players in the winter season.

In Poland, there was a significant increase in the use of renewable energy sources in households, with stagnation in the use of non-renewable energy sources, such as hard coal (Piekut, 2021).

Mejriszan *et al.* (2018) ^[11] revealed that India has the lowest

energy consumption per population, while the U.S. and Canada have the highest. Germany has the lowest energy consumption per GDP, indicating high energy efficiency, while Iran has the highest.

The survey conducted by Mansouri *et al.* (1996) ^[12] indicated that people were interested in information about household energy use and its environmental impact, and were willing to change their behavior to reduce consumption and damage. Therefore, providing end-users with clear, accurate and persuasive information about energy consumption and its environmental impact is crucial to encourage energy-efficient and environmentally sustainable practices.

Shaanxi (2008) ^[13] found that the amount of energy used for entertainment and electric appliances was greater in urban areas, whereas the quantity used for cooking was larger in rural districts. People in village were completely depended on fuelwood for cooking and heating. In the township, 16.7 per cent household used coal ball and 23.3 per cent used LPG. Electricity and fuelwood were used in each household. Peter *et al.* (2007) ^[14] analysed the energy and greenhouse gas emissions attributable directly or indirectly to urban form. There was clear evidence from both intra and intercity comparisons that higher density, transit-oriented cities had lower per capita transport energy use, the effect of housing density on residential (in-house) energy use was less clear.

Benjamin (2009) ^[15] highlighted a misinformation about energy amongst public. People were having lack of understanding of why wind or solar technologies were needed, rather than a belief that they are inferior to fossil fuels.

Khan and Halder (2016) ^[16] reported that electrical energy could be saved from 3 per cent to 20 per cent through behaviour change amongst respondents.

Muhammad *et al.* (2024) highlighted the importance of promoting sustainable consumption and environmentally conscious behaviour to reduce carbon emissions. It emphasized the negative impact of hedonic adaptation on carbon emissions, while also showcasing the positive influence of media penetration and government communication in fostering sustainable practices. Policy makers could implement effective strategies, including incentives for alternative energy and promoting environmentally aware consumerism, to combat environmental damage and encourage a better future.

Research methodology

There were 200 respondents for conducting the research. Hundred respondents from rural (Dantiwada) area and hundred from urban area (Palanpur) were selected randomly. The sample of the present study was two hundred respondents. Hundred respondents will be randomly selected each from rural and urban areas of Banaskantha district of Gujarat. Simple random sampling method will be used for selection of respondents.

Results and Discussion

The subsequent tables are related to the energy consumption pattern of the respondents on how they consume different types of energy in day to day life.

Table 1: Distribution of respondents on the basis of age (n=200)

Age	Urban		Rural		Chi square value
	f	%	f	%	
Young (up to 35 years)	38	38.00	20	20.00	15.479** (P<0.01)
Middle (35-50 years)	50	50.00	47	47.00	
Old (above 50 years)	12	12.00	33	33.00	
Total	100		100		

Table 1 the results revealed that in urban area 38.00 per cent respondents were, 50 per cent were in middle age group and 12 per cent were in old age group. The results also revealed that in rural area, 20 per cent were young people, 47 per cent were middle age people and 33 per cent were old age people. The Chi square test value was found significant i.e., 15.479. There was significant difference between age distribution of respondents in rural and urban areas.

Table 2: Distribution of respondents on the basis of number of children (n=200)

Number of children	Urban		Rural		Chi square value
	f	%	f	%	
0-2	80	80.00	62	62.00	7.935* (P=0.019)
3-4	18	18.00	35	35.00	
5-6	02	02.00	03	03.00	
Total	100		100		

Table 2 the results show that majority of the respondents i.e., 80 per cent had 0-2 number of children, 18 per cent respondents had 3-4 children and only two per cent had 5-6 children in urban areas. The results also reveals that in rural areas maximum 62 per cent respondents had 0-2 children, followed by 35 per cent who had 3-4 children and only three per cent had 5-6 children. The chi square test value is 7.935 that means significant difference between number of children possessed by respondents in rural and urban areas.

Table 3: Distribution of respondents on the basis of family type (n=200)

Family type	Urban		Rural		Chi square test
	f	%	f	%	
Joint	49	49.00	100	100.00	64.901** (P<0.01)
Nuclear	51	51.00	00	0.00	
Total	100		100		

Table 3 shows that in urban area, 49 per cent respondents

were living in joint family and 51 per cent had nuclear family. According to the present investigation in rural areas 100 per cent respondents had joint family in rural areas. The chi square test value is 64.901 it means that there is a significant difference between rural and urban family type.

Table 4: Distribution of urban respondents on the basis of vehicle they use (n=100)

Type of Vehicle	Urban	
	f	%
Bike	39	39.00
Bike and car	23	23.00
Bike, car and scooty	22	22.00
Bike and scooty	03	03.00
Car	08	08.00
Scooty	05	05.00

Table 4, indicates that maximum thirty nine per cent respondents in urban area used only bike followed by bike + car (23.00%) and bike+car+scooty (22.00%). All the respondents were using vehicles and almost half of the respondents were using more than one vehicle.

Table 5: Distribution of urban respondents on the basis of energy they use for vehicle (n=100)

Energy used for vehicle	Urban	
	f	%
Petrol	89	89.00
Diesel	26	26.00
CNG	08	08.00

Table 5 shows that majority (89.00%) of the respondents were using petrol as fuel for their vehicles followed by diesel (26.00%). While only eight per cent respondents were using CNG fuel for their vehicle. People using petrol for vehicle were 53 per cent in urban area. It can be stated that CNG should be promoted more as clean energy amongst respondents.

Table 6: Distribution of rural respondents on the basis of vehicle they use (n=100)

Type of Vehicle	Rural	
	f	%
Bike	90	90.00
Bike and car	02	02.00
Bike, car and scooty	01	01.00
Bike and scooty	03	03.00
Bike and auto	01	01.00

Results presented in Table 6 revealed that majority of the respondents of rural area were using bike while only ten per

cent respondents were using more than one vehicle.

Table 7: Distribution of rural respondents on the basis of energy they use for their vehicle (n=100)

Type of Vehicle energy	Rural	
	f	%
Petrol	100	100.00
Diesel	006	006.00

Data in Table 7 reveals that hundred per cent respondents were using petrol and only six per cent were using diesel also in their vehicles.

Table 8: Distribution of respondents on the basis of type of energy they use at home (n=200)

Urban (100)		
Types of energy used at home	f	%
LPG+Diesel+Electricity+Petrol	18	18.00
LPG+Diesel+Electricity+Petrol+Solar Energy	08	08.00
Electricity+Petrol+LPG	53	53.00
Diesel +Electricity+LPG	21	21.00
Rural (100)		
Types of energy used at home	f	%
Diesel +Electricity+LPG	01	01.00
Electricity+Petrol	09	09.00
Diesel+Electricity+Petrol	11	11.00
LPG+Diesel+Electricity+Petrol	09	09.00
Diesel+Electricity+Petrol+LPG+Solar Energy	09	09.00
Electricity+Petrol+LPG	45	45.00
Electricity+Petrol+LPG+Solar Energy	01	01.00
Diesel+ Electricity+LPG	15	15.00

Results presented in Table 8 reveals that maximum respondents i.e., 53 per cent and 45 per cent were using electricity, petrol and LPG in urban and rural area respectively. Twenty-one per cent respondents in urban area and 15 per cent in rural area were using diesel, electricity and LPG. In urban area, solar energy was used by eight per

cent respondents along with other energies but in rural area solar energy was used by only one respondent.

Shahi (2019) ^[4] conducted a study in Nepal and collected data from 442 households in three regions of Nepal i.e., Kalikot (a rural area), Chitwan (a semi-urban area) and Kathmandu (an urban area). He reported that the electricity was used only for lighting purposes in the rural area, but other electrical appliances were used in semi-urban and urban areas. The amount of electricity use had not affected by household income level in the rural area, but it had affected in semi-urban and urban areas. The level of education affected the use of the LED significantly.

Table 9: Distribution of respondents on the basis of energy they rely (n=200)

Type of energy	Urban		Rural	
	f	%	f	%
Electricity	32	32.00	33	33.00
Petrol	38	38.00	37	37.00
Diesel	30	30.00	30	30.00
Total	100		100	

Table 9 shows that maximum 38 per cent respondents in urban area and 37 per cent in rural area rely on petrol as energy. Electricity was reported by 32 per cent respondents in urban area and 33 per cent in rural area. Likewise, thirty per cent respondents each in urban and rural area reported diesel as the most reliable energy.

Table 10: Distribution of respondents on the basis of energy expenditure of the respondents (n=200)

Energy	Average monthly expenditure on energy (₹) in urban area	Average monthly expenditure on energy (₹) in rural area
Electricity	2961.00	2480.00
Petrol	2319.00	2460.00
Diesel	1267.00	6997.00
LPG	873.50	747.00
CNG	228.00	0.00
Solar Energy	0.00	0.00

Table 10 reveals that the average monthly expenditure on electric energy was found ₹2961.00 in urban area and ₹ 2480.00 in rural area. The average monthly expenditure on petrol was higher in rural area as compared to urban area. Surprisingly, the average monthly expenditure on diesel was very high in rural area i.e., ₹ 6997.00 as compared to urban area. The reason might be the utilization of diesel for tractor

in rural area. The average monthly expenditure on LPG was more (₹873.50) in urban area as compared to rural area which was ₹747.00. The average monthly expenditure on CNG was found monthly expenditure on ₹228.00 in urban area. There was no expenditure on solar energy on monthly basis.

Table 11: Distribution of respondents on the basis of equipment they use at home (n=200)

Name of equipment		Urban (100)		Rural (100)		Chi square value
		f	%	f	%	
TV	Using	70	70.00	74	74.00	0.397 (P=0.529)
	Not using	30	30.00	26	26.00	
Refrigerator	Using	100	100.00	74	74.00	29.885** (P<0.01)
	Not using	0	0.00	26	26.00	
Washing machine	Using	60	60.00	04	04.00	72.059** (P<0.01)
	Not using	40	40.00	96	96.00	
AC	Using	19	19.00	04	04.00	11.054** P<0.01
	Not using	81	81.00	96	96.00	
RO	Using	61	61.00	0	0.00	87.770** (P<0.01)
	Not using	39	39.00	100	100.00	
Cooler	Using	53	53.00	18	18.00	26.750** (P<0.01)
	Not using	47	47.00	82	82.00	
Tractor	Using	0	0.00	25	25.00	28.571** (P<0.01)
	Not using	100	100	75	75.00	

*Chi-square significant at 0.5 level of significance

The result shows that, in urban area TV was used by 70 per cent in urban area and 74 per cent in rural area (Table 11). Chi square value is non-significant. Hundred per cent respondents were using refrigerator in urban area and 74 per cent in rural area. Washing machine was used by 60 per cent respondents in urban area while only four per cent respondents were using it in rural area.

AC was used by 19 per cent respondents in urban area and only four per cent respondents in rural area. RO was also used by 61 per cent respondents in urban area while no one

was using it in rural area. Cooler was used by 53 per cent in urban area and 18 per cent were using in rural area. Tractor was used by one-fourth of the respondents in rural area and no one was using in urban area. Significant difference was found in using pattern of all equipment between urban and rural area except TV, which was the most popular one.

The result also shows that TV, RO and refrigerator were used daily in urban and rural area. Washing machine was used weekly while rest of the equipment were used need based and as per season.

Table 12: Years of purchase of equipment (n=200)

Equipment	Years of purchase	Urban (100)		Rural (100)		Chi square value
		f	%	f	%	
TV	01	08	08.00	0	0.00	37.997** (P<0.01)
	02	21	21.00	19	19.00	
	03	39	39.00	19	19.00	
	04	02	02.00	19	19.00	
	05	0	0.00	03	03.00	
	06	0	0.00	08	08.00	
	07	0	0.00	03	03.00	
	08	0	0.00	03	03.00	
Refrigerator	01	0	0.00	26	26.00	59.640** (P<0.01)
	02	0	0.00	08	08.00	
	03	10	10.00	02	02.00	
	04	22	22.00	05	05.00	
	05	34	34.00	18	18.00	
	06	13	13.00	21	21.00	
	07	06	06.00	05	05.00	
	08	07	07.00	11	11.00	
	09	07	07.00	04	04.00	
Washing machine	01	08	08.00	0	0.00	74.824** (P<0.01)
	02	12	12.00	0	0.00	
	03	15	15.00	0	0.00	
	04	13	13.00	04	04.00	
	05	06	06.00	0	0.00	
	06	06	06.00	0	0.00	
AC	02	08	08.00	0	0.00	34.130** (P<0.01)
	04	0	0.00	04	04.00	
	06	12	12.00	0	0.00	
	07	07	07.00	0	0.00	
RO	01	05	05.00	0	0.00	100.752** (P<0.01)
	03	14	14.00	0	0.00	
	04	27	27.00	0	0.00	
	05	07	07.00	0	0.00	
	06	08	08.00	0	0.00	
	07	06	06.00	0	0.00	
Cooler	01	0	0.00	02	02.00	69.043** (P<0.01)
	02	13	13.00	04	04.00	
	03	12	12.00	0	0.00	
	04	15	15.00	05	05.00	
	05	21	21.00	0	0.00	
	06	0	0.00	03	03.00	
	07	06	06.00	04	04.00	
Tractor	06	0	0.00	01	01.00	28.571** (P<0.01)
	08	0	0.00	07	07.00	
	09	0	0.00	07	07.00	
	10	0	0.00	04	04.00	
	11	0	0.00	04	04.00	
	15	0	0.00	02	02.00	

*Chi-square significant at 0.5 level of significance

Table 12 reveals that maximum 39 per cent respondents purchased TV before three years in urban area and majority

of respondents purchased TV before two to four years in rural area. Maximum (34.00%) respondents from urban area

had purchased refrigerator before five years 21 per cent in rural area took it before six years. Almost half of the respondents purchased washing machine within 1-4 years in urban area. AC was purchased before six years by 12 respondents in urban area. Maximum 27 per cent respondents were using four years old RO followed by three years. Two - five years old cooler was used by majority of respondents. Two respondents had 15 years old tractor while 14 per cent respondents had 8-9 years old tractor in rural area. It can be inferred from the data that equipment using by respondents were less than 10 years old.

Table 13: Consumption of electricity at farm in kW (n=200)

Electricity consumption in kw	Urban		Rural		Chi square value
	f	%	f	%	
20-25	20	20.00	34	34.00	196.040** (P<0.01)
25-30	08	08.00	66	66.00	
Total	100		100		

*Chi-square significant at 0.5 level of significance

Data shows that twenty per cent respondents in urban areas were using 20-25 kW electricity at their farm followed by eight per cent using 25-30 kW electricity. While, 25-30 kW electricity was used daily at the farm for different activities by 66 per cent rural respondents followed by thirty-four per cent respondents who were utilizing 20-25 kW electricity daily for farm activities (Table 13).

All the respondents in both urban and rural area reported that they had good access to electricity. This is pointer to the fact that electricity demand is fulfilled without any hurdles in rural and urban areas of Banaskantha district.

Table 14: Distribution of respondents on the basis of awareness about Government scheme for renewable energy (n=200)

Government scheme	Urban		Rural		Chi square value
	f	%	f	%	
Yes	95	95.00	62	62.00	32.262** (P<0.01)
No	05	05.00	38	38.00	
Total	100		100		

*Chi-square significant at 0.5 level of significance

According to the data presented in Table 14, majority of the respondents (95.00%) were aware about government schemes in urban area for renewable energy while sixty-two per cent respondents in rural area were also aware of it. Chi square was found significant.

Table 15: Distribution of respondents on the basis of their plan to install solar panels (n=200)

Plan for solar panel	Urban		Rural		Chi square value
	f	%	f	%	
Yes	22	22.00	56	56.00	22.296** (P<0.01)
No	78	78.00	44	44.00	
Total	100		100		

*Chi-square significant at 0.5 level of significance

Table 15 reveals that in urban 22 per cent and in rural area 56 per cent were willing to install solar panels. On the contrary, 78 per cent respondents in urban and forty-four per cent respondents in rural area were not willing to install solar panel, significant difference was found in urban and rural respondents' willingness to install solar panels.

Table 16: Distribution of respondents on the basis of energy cost (n=200)

Energy cost	Urban		Rural		Chi square value
	f	%	f	%	
Yes	63	63.00	43	43.00	8.029* (P<0.005)
No	37	37.00	57	57.00	
Total	100		100		

*Chi-square significant at 0.5 level of significance

Table 16 discloses that 63 per cent in urban and in 43 per cent respondents in rural area considered energy cost as a significant burden on them.

Table 17: Distribution of respondents on the basis of their interest in learning energy efficient practices (n=200)

Interested in energy efficient farming	Urban		Rural		Chi square value
	f	%	f	%	
Yes	86	86.00	40	40.00	45.388** (P<0.01)
No	14	14.00	60	60.00	
Total	100		100		

*Chi-square significant at 0.5 level of significance

It is revealed from Table 17 that 86 per cent in urban and 40 per cent respondents in rural area were interested in learning more about energy efficient practices. There was a significant difference between interest of urban and rural respondents.

Conclusion

Maximum respondents belonged to middle age group i.e., (50.00%) in urban and (47.00%) in rural area. Maximum number of urban and rural respondents were having (0-2) number of children i.e, 80 per cent and 62 per cent respectively. Half of the urban respondents were having nuclear family i.e (51.00%) and 100 per cent rural respondents were having joint family.

The study revealed that maximum respondents rely on petrol followed by electricity. Maximum expenditure of the respondents was on electricity in urban area in rural area it is on diesel. Maximum urban respondents were using several household equipment but in rural area very few of them were using household equipment. Most of the equipment were used daily in both rural and urban areas and run on electricity. Maximum rural and urban respondents were using equipment for long time. Maximum rural respondents used 25-30 kW power daily at their farm. All the respondents reported good access to electricity in both the areas. Maximum urban and rural respondents knew government schemes for renewable energy. Maximum respondents had no plan to install solar panels in urban but in rural, more than half of the respondents planned to install solar panels. Maximum urban respondents think energy cost is burden on them while rural respondents think it is not a burden on them. Maximum urban respondents had interest in learning more about energy efficient practices but rural people showed no interest. Energy consumption pattern of respondents showed that they relied more on conventional energy. There is a need to transit from conventional energy to renewable energy for better future.

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