

A little warmth in life urban-rural differentials in energy consumption in Mumbai region of India

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Key Words

Household Energy Consumption, Urban- Rural Differentials

Abstract

This paper is a micro level attempt to bring forth the urban-rural differentials in household energy consumption in the Mumbai Region of India. The dualistic character (urban-rural) of the economies of most of the developing Asian economies like India, tend to project a very backward, non-commercial energy users' agony on one hand and a very affluent and modern commercial energy users' prospering elite existence on the other. The per capita energy consumption levels in these developing economies are far more lower compared to those in the developed countries.

India needs to focus more on the Energy and Electricity Policy to provide her enormous population with a minimum accessibility to more convenient sources of energy such as electricity which will enable an extensive use of some basic electrical appliances and would enhance the quality of life for the masses. The urban Indian centers have very high levels of electricity consumption with uninterrupted supply, semi-urban areas suffer from unavoidable load shading problem and the rural areas have a very meagre supply of electricity.

A detailed questionnaire was administered to the randomly selected households in the urban, semi-urban and rural areas in and around the Mumbai region. The questions included in the questionnaire were designed keeping in mind some broad household energy consumption indicators. Simple Linear Regressions and Multinomial Logit were used to analyse the data. Number of Members in the Family, Income, Average Units of Electricity Consumed per month, No. of Electric Bulbs or Tube-lights used in the household, Use of Electric Mixer-Grinder, Number of Mobile Phones in use per family were found to be statistically significant determinants of household electricity consumption. A brief account of fuel-mix in terms of the household consumption of LPG, diesel (petrol) and the use of some innovative and renewable sources of energy also was taken in this research.

Introduction

In many developing countries of the Asia-Pacific region, households still rely largely on non-commercial energy. They rely heavily on bio-fuels, such as wood-fuel, biomass (crop and livestock residues) and charcoal, which are generally not included in official energy data. According to the Food and Agricultural Organization of the United Nations (FAO) Regional Wood Energy Development Programme, wood-fuel contributes more than 90 per cent of the energy requirements of households in some areas.

In the Asian developing countries, many households use bio-fuel mainly for cooking. The reliance on bio-fuels is obviously more in case of the rural households than the urban households. In Bangladesh, households account for 78 per cent of total biomass consumption in the country. Agriculture residues and animal dung contribute significantly to rural household energy consumption in India and Pakistan.

In India, particularly the rural households still predominately rely on non-commercial fuels. Firewood, crop residues and dung cake provide a high portion of household energy

consumption. On the average, biomass fuels supply 94.9 per cent of rural household and 41.5 per cent of urban household energy. Urban consumers with higher incomes consume LPG mainly for cooking purpose. With the advent of economic development, the trend towards consumption of more convenient fuel, in particular, electricity and better fuel-mix has continued to grow and is getting accelerated along with the pace of urbanization.

Urban residents and rural social groups with higher incomes consume more energy than other groups. Urbanization brings with it both higher household income levels and greater accessibility to modern fuels. Urban areas have a better infrastructure to supply modern fuels as well. Low-income Indian households consume very little modern fuels and electricity.

Energy Consumption and Economic Growth

Energy is the prime mover of economic growth and greatly contributes to generation of wealth. Availability of energy with required quality of supply is not only key to sustainable development, but commercial energy also has a direct impact and influence on the quality of service in the fields of education, health and even for food security. Inadequacy of energy supply would obviously affect very adversely these vital and essential requirements of any society. There is, therefore, an urgent need to enhance substantially the energy availability at a rapid pace so that aspirations of those who have remained away from such important inputs and services are fulfilled and they are enabled to have a reasonable access.

There is a big divide between the developed and the developing countries in per capita availability of energy. The developed countries not only have a significantly higher per capita energy consumption but also mainly depend on commercial energy. On the other hand, developing countries are highly energy deficient and also the large proportion of energy consumed is comprised of non-commercial energy sources such as bio-mass. As per the projections made by International Energy Agency (IEA), most of the developing countries are not expected to reach, even by the year 2030, the level of Energy Development Index achieved by the OECD countries way back in 1971. Therefore, what is needed is, a large investments in energy infrastructure and technology transfer strategies to expand the reach of commercial energy to all the countries as per their developmental needs and it needs to be given a priority.

Energy Consumption in India

Per capita electricity consumption in India is only 615 Kwhr (kilowatt-hour) per year as compared to world average of 2516 Kwhr and 1585 Kwhr in China

In India, in the last few decades rapid economic growth and higher incomes have raised the demand for electricity very rapidly (6 per cent pa). There is large differential in energy and electricity consumption among the Rural, Semi-Urban and Urban Metropolitan cities in India. The urban centers have very high levels of electricity consumption with uninterrupted supply, semi-urban areas suffer from unavoidable load shading problem and the rural areas have very meagre supply of electricity. Due to poverty and low incomes even cooking fuel (LPG) is unaffordable for majority of the poor rural households.

As per the data of 2004, around 26 per cent villages i.e. 56.5 per cent households had no access to electricity. There are social, economic and environmental dimensions of energy scarcity in rural India. As the Non-renewable sources of energy are depleting, an increasing need is being experienced for exploring the Renewable sources of energy such as Solar, Wind etc.

Household energy consumption

Energy is required to satisfy some basic needs at the household level. Household energy consumption can be defined as the energy consumed in homes to meet the needs of the householders themselves. Thus, for example, cooking food at home for the household is

included, while cooking food for sale is not, and nor is food processing and preparation undertaken. The final energy consumption of households is often called residential energy consumption and it covers the energy consumed in household dwellings.

The pattern of household energy consumption represents the stage of welfare as well as the stage of economic development. As the economy develops, more and cleaner energy is consumed. With rising incomes, it is natural for people to pursue a better life, proper heating and cooling, and use of more equipment. Over a period of time an increase in household energy consumption is expected to result from changes in lifestyles. An analysis of household energy consumption patterns may also help to formulate policies for promotion of sustainable energy consumption.

Electricity is the most convenient form of household energy consumption as it makes the use of electric appliances possible. During the past few decades, electricity consumption has grown faster than any other fuel. And the growth rate of per capita household electricity consumption in the Asia & Pacific region has outnumbered the growth rate of per capita income. Residential electricity consumption in China has tended to grow faster than national electricity consumption.

The primary factors which influence total energy consumption are population growth and levels of household incomes. Significant changes in energy consumption have recently occurred as a result of changes in technology, income levels and lifestyles. The main factors influencing household energy consumption growth are per capita income growth, fuel shifts, demographic changes and consumption pattern by income.

With increases in GNP per capita, changes in energy consumption occur. Energy consumption grows as income increases. It also switches from traditional to conventional energy sources (Phase I) and from fossil fuels to more convenient energy, at least for a part of the population (Phase II). A positive relation between energy consumption and Human Development Index also has been highlighted by some empirical studies.

In China, due to rapid dissemination of electrical home appliances, electricity use increased more than fourfold during the period 1980-1998. Electricity currently accounts for 37 per cent of household energy consumption in China. However, coal remains the main fuel used to generate electricity and so, households still indirectly consume a large amount of coal. The use of liquefied petroleum gas (LPG), town gas, and natural gas, has risen about 14.5 per cent.

Small households in Republic of Korea use more energy per person than large families. A person in a 2-member family consumes 4 Mtoe annually, whereas a person in a household with more than six members consumes only 1.3 Mtoe per year. Even though the nuclear family uses less total energy, large families synergize their energy use. The share of electricity in a small family is higher than in large families. All households prefer convenient energy. Nuclear families tend to live in urban areas. This may be one factor that explains the higher energy consumption in urban areas, apart from easy access to the commercial energy grid and higher income.

In many countries productive sectors' energy efficiency gains are being realized together with technical progress and modernization. Recent efficiency gains achieved by compact fluorescent lamps (CFL) are a good example of continuing improvement in electrical appliances. CFLs consume 84 per cent less electricity than incandescent light bulbs. Countries can save energy through programmes that replace incandescent lamps by CFLs. The energy efficiency of many other electrical appliances is also being improved which will rationalize the household energy consumption.

Energy Policy in India

Most developing countries include rural electrification programs in their efforts to improve social conditions. There are, however, several obstacles to the evaluation of such programs and therefore of their social, economic, environmental and energy impacts on the target population, particularly on impoverished communities located in remote areas. The provision of electric energy amounts to more than an access to a public service and is more or less considered to be an essential right, in a context of social equity and justice, which permits social integration and the access to other equally essential services.

Broad **objectives** of Indian energy policy have been, access to electricity for all households, supply of Reliable and Quality Power of specified standards in an efficient manner and at reasonable rates, increase in Per capita availability of electricity, village electrification and household electrification to achieve the target of complete household electrification and financial support in terms of capital subsidy to States for rural electrification.

As per the Economic Survey of Government of India 2011, under the *Rajiv Gandhi Grameen Vidyutikaran Yojana* (RGGVY), (Rural Electrification Program), around 8779 villages have been electrified and connections have been released to 135.31lakh below poverty line (BPL) households up to November 30, 2010. Several measures have been taken by the Ministry of Power and Bureau of Energy Efficiency (BEE) to promote energy conservation. The XIth Five Year Plan (2007-12) aimed at achieving inclusive growth in the Indian economy, energy being one of the thrust areas.

Limited fossil resources and environmental problems associated with them have emphasized the need for new sustainable energy supply options that use renewable energies. World Energy Council-Indian Member Committee Draft Report April 2010 has discussed in detail, the large rural –urban differentials in energy consumption and barriers to energy access for rural India and Government initiatives, approaches for meeting rural energy needs and the use of renewable sources of energy such as the Solar power as bridge to the future energy needs. Various studies of the Asian Development Bank also have highlighted the need for renewable sources of energy.

Use of Renewable Sources of Energy

Solar thermal power generation systems also known as Solar Thermal Electricity (STE) generating systems are the emerging renewable energy technologies and can be developed as viable option for electricity generation in future, particularly in India and the host Indian sub continent. Some Municipal corporations in some states of India have made installation of Solar Panel mandatory especially for the new residential and commercial establishments.

There are a large number of wind mills operating in Thirunelveli-Kanyakumari districts of Tamil Nadu providing power to thousands of households, under private enterprise. In order to introduce and increase the extent of competition in the electricity market, Ministry of Power, Government of India has recently announced a scheme of Merchant Power plants.

Unlike traditional utilities, Merchant Power Plants compete for customers and absorb the full market risk. There are no guarantees that they will have a minimum off-take of their output. They must respond to market. Merchant Power Plants can provide the additional generating reserves that India needs now and will need in the future. They can be regarded as the modern, market-based answer – at least in part – to energy challenges faced by the country.

Merchant Power Plants are a product of the restructuring of the electricity industry. They fulfill different niches in the market; some provide steady supplies to a power grid, while others fire up only when demand is highest and meet peak loads. Merchant power plants operating competitively help assure that power is produced with efficiency and supplied to locations where it is needed most.

The Current Study

The current study planned to investigate into the large rural-urban differences in the consumption of electricity and energy in and around the Greater Mumbai, Thane and Raigarh districts of the State of Maharashtra. The aim was to bring forth the large differences in availability and affordability of the energy sources in the rural and urban areas. An attempt has been made to establish a causal relationship between the urban and rural income levels, family size, use of basic electrical appliances and the extent of energy consumption.

The **objectives** of the study were;

- a) To study Urban-Rural differences in Energy and Electricity consumption
- b) To find out the extent to which the use of electric appliances has been facilitated by use of electricity in the urban and rural households and with the high income enabled advent of lifestyle
- c) To observe the fuel-mix of urban and rural households
- d) To find out if any efforts are being made to increase awareness regarding better usage of nonrenewable sources of energy and more effective usage of alternative and renewable sources of energy at individual and community level.

Methodology

A list of energy indicators as a guideline methodology to assess the sustainable development has been discussed in the Report Published by the United Nations Department of Economic & Social Affairs and International Atomic Energy Agency. In this report, **social and economic** indicators pertaining to the household energy consumption have been listed out. The current study has used these guidelines to prepare the questionnaire that was administered to the households.

In this report, the Social indicator for energy consumption of the households was labeled as **Equity**. Under this the following aspects were indicated.

1 Accessibility Indicator: Share of households (or population) without electricity or commercial energy, or heavily dependent on non-commercial energy,

2 Affordability Indicator: Share of household income spent on fuel and electricity

3 Disparities Indicator: Household energy use for each income group and corresponding fuel mix

As **Economic** indicators, Energy use per capita, Energy use per unit of GDP, Industrial/Agricultural/ services energy intensities, Household energy intensities were laid down in this report in terms of the definition, 'Amount of energy use by residential end use per person or household or unit of floor area, or per electric appliance.'

It was proposed to assess the Rural, Semi-Urban and Urban household consumption of electricity and energy by surveying around sixty households from each geographical area in and around greater Mumbai. A detailed questionnaire was administered to each randomly selected household from the three geographical areas to find out the usage of electricity (in terms of electric bulb or tube lights, fans and other appliances) expenditure on cooking gas or kerosene and the consumption of transportation fuel, if any, per month.

The city of Mumbai, the semi-urban area of Kalyam-Dombiwali & Vasai-Virar and the rural areas of Thane & Raigarh districts were covered for obtaining relevant information for the study.

Variable	No. of Obs	Mean	Std. Dev.	Min	Max
Location	181	1.574586	.7462614	1	3
No.of Memb in fmly	181	2.325967	.7294136	1	5
Income	180	2.927778	1.382373	1	5
AverageBill (Rs)	181	2340.768	2662.294	153	15154
Ave units consumed	181	390.7901	385.7531	29	2664
No. of switches	181	3.281768	.9208385	1	4
No. of Bulbs	181	2.767956	.9552607	1	4
No. of fans	181	1.933702	.6463763	1	3
No. of oven	181	.3922652	.4896097	0	1
Microvave	181	.6629834	.4740018	0	
Mixi	181	.9502762	.2179766	0	1
Refrigerator	181	.9723757	.1643485	0	1
Television	181	.9889503	.1048253	0	1
CD Player	181	.7292818	.4455634	0	1
Eletric Geezer	181	.8176796	.3871794	0	1
Washingmachine	181	.8508287	.3572454	0	1
No.of Computers	181	.7348066	.6203526	0	3
No. of Laptops	181	.9944751	.8530809	0	5
No.of Air condi	181	1.685083	1.368393	0	7
No.of Mobiles	179	3.709497	1.511926	0	10
No of Two-wheelers	180	3.401944	7.532126	0	5
NO of Four- wheels	181	.4972376	.5013793	0	3
Petrol in Rs	177	3591.085	6504.645	0	12000
Petrol in iters	175	51.59371	94.62068	0	170
LPG/Pipe GAS	179	1.307263	.4626533	400	1500

Observations pertaining to the use of Domestic appliances:

Almost all the households included in the study had a Television in their house. In urban area 62 households, in semi-urban area 32 out households and in rural area 20 houses had a CD Player. Around 63 Urban, 34 Semi-urban and 15 Rural houses had a computer in their house. No. of mobile phones per house was 0-10 for the Urban and the Semi-urban areas and 2-5 in the rural area. Around 26 Urban, 31 Semi-urban and 7 Rural households owned a two wheeler and monthly expenditure on petrol ranged from Rs 300 to Rs 2500 per month. 52 Urban, 20 Semi-urban and 7 Rural households owned a four wheeler and amount of petrol consumed per month for these households was 7 to 170 liters per month. The results have been obtained using linear regression and Multinomial Logit of Categorical Regression (with help of STATA)

Linear Regression:

Result 1

Using linear regression, when Location of household was considered as a regressand, the regressors, Number of Members in Family (noofmemb), Total Household Income (income), Average Units of Electricity consumed per month by a household (avunitcons), No. of Electric Bulbs or Tube-lights used in the house (bulbs), Use of Electric Mixer-Grinder (mixi), Number of mobiles used by the family members (noofmob) were found to be statistically significant.

	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
noofmemb	.2054245	.0761024	2.70	0.008	.0551971 .3556519
income	-.1192686	.0423755	-2.81	0.005	-.2029185 -.0356187

avunitcons		-.0002573	.0001428	-1.80	0.073	-.0005391	.0000245
bulbs		-.1771811	.0588908	-3.01	0.003	-.2934324	-.0609298
mixi		.4373258	.237914	1.84	0.068	-.0323203	.906972
noofmob		-.0874684	.0388106	-2.25	0.025	-.1640811	-.0108556
_cons		2.745397	.6879683	3.99	0.000	1.387336	4.103458

Result 2

When Average Units of Electricity Consumed per month by a household (avunitcons) was considered as a regressand, Income of the household (income), Number of Air conditioners used in a household and Use of mobile phones by the family members (mobilyn) were found to be statistically significant determinants.

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regress avunitcons noofac income mobilyn
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avunitcons		Coef.	Std. Err.	t	P> t	[95% Conf. Interval]
noofac		113.5516	19.86636	5.72	0.000	74.34464 152.7585
income		65.8664	19.64721	3.35	0.001	27.09196 104.6408
mobilyn		-792.5607	325.5597	-2.43	0.016	-1435.064 -150.0575
_cons		795.2672	325.6337	2.44	0.016	152.618 1437.916

Multinomial Logit

As the three categories of respondents, namely, Urban, Semi-urban & Rural were included in the survey, Multinomial Logit of Categorical Regression was used to analyse the determinants of energy consumption and the results were found in five iterations.

The urban households was found to be the base category. When Location of household (three categories of Urban, Semi-urban & Rural) was considered as a regressand, the regressors- Number of Membars in Family (noofmemb), Household Income (income), Average Units Consumed per month,(avunitcons) Average Monthly bill in Rupees were found to be statistically significant.

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mlogit location noofmemb income avbillinrs avunitcons
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Multinomial logistic regression

Number of obs	=	180
LR chi2(8)	=	72.66
Prob > chi2	=	0.0000
Pseudo R2	=	0.2121

Log likelihood = -134.93351

location		Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
1		(base outcome)				
2						
noofmemb		.0890462	.2673615	0.33	0.739	-.4349727 .6130652
income		-.0657058	.1563334	-0.42	0.674	-.3721136 .2407021
avbillinrs		.0000305	.0003441	0.09	0.929	-.000644 .0007049
avunitcons		-.0060107	.0029227	-2.06	0.040	-.0117391 -.0002823
_cons		1.072124	.7414481	1.45	0.148	-.3810871 2.525336
3						
noofmemb		.9670277	.3795321	2.55	0.011	.2231586 1.710897
income		-.9023948	.2854182	-3.16	0.002	-1.461804 -.3429855
avbillinrs		.0009403	.000473	1.99	0.047	.0000132 .0018673
avunitcons		-.0137981	.0047361	-2.91	0.004	-.0230806 -.0045156
cons		.8011314	.9998116	0.80	0.423	-1.158463 2.760726

Most of the very poor and remote rural households included in the study had only two to three electric bulbs in their house and no other usage of electricity was found. Those who were slightly better off had a electric fan and a television set. Most of the households did not have a LPG for cooking purposes and they mainly depended on fire-wood. The farmers who owned cattle have successfully installed bio-gas in their houses with help of credit taken from banks and it is used for domestic cooking purpose. A two-wheeler is mainly used for local commuting in such areas.

In the semi-urban areas, load shading is common and that has impaired the use of computers and air conditioners. In the Urban areas, a large scale use of electrical appliances is found very common. It was also observed that the use of two and four wheelers and fuel consumption is on the rise in the semi-urban and urban areas.

With the advent of urbanisation and long term energy policy, it will be possible to achieve a rise in per capita energy consumption and an enhancement in energy-enabled quality living for the larger numbers of the growing Indian population.

Conclusion

The outcome of this survey has been quite encouraging although, the survey was a micro level effort to study the urban-rural differentials in energy consumption. The results of this study have reiterated the close relation between use of energy, economic growth, rising incomes and social and economic wellbeing. A more extensive time series-cross section analysis of different urban and rural areas in Indian states can shed more light on these findings.

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