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Sustainable Residential Electricity Consumption - A study of Jaipur City

KEYWORDS: Power Deficit, Economic Development, DSM

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ABSTRACT *Being considered as the backbone for an economy's progress; electricity plays a critical role in socio economic development of a nation. Consumption of power and development of an economy are positively correlated to one another. No doubt our economy has witnessed rapid economic development in the past few decades which has in turn led to increase in the power consumption manifold i.e. from 559 KWh in 2000-2001 to 1000 KWh in 2011-12. Eventhough consumption of power is considered to be a positive indicator of growth but the ever increasing consumption of power has given rise to serious problems such as global warming, growing power deficit and mounting debt. In the present research article attempt has been made to investigate the effective determinants of residential electricity demand in Jaipur city using Multi Nomial Logistic Regression model. Consumption of power in residential sector of India has increased from 72,200 Million Kilowatthours in 1950 to 13, 91, 090 Million Kilowatthour in 2013 and residential sector accounts for around 40 per cent of total electricity consumption and therefore there is a good potential of energy conservation in residential sector. Present research article is an effort to enable the policy makers to frame effective DSM strategies to curb excessive demand and bring a balance between the growing demand and supply of power.*

1. Introduction

Development of power is a decisive factor for the growth for the growth and success of any economy. Power form a crucial component of the country's infrastructure. Realizing the importance of the power the State Electricity Board (RSEB) was formed on 1st of July 1957. To strengthen this basic infrastructure around 30 per cent of total budget outlay is being spent towards the growth of this sector. The state power sector has witnessed rapid growth of around 9 per cent per year (Rajasthan Power Sector Vision) but despite the increasing growth rate of state power sector and continuous efforts taken by the government in the past few decades, Rajasthan has been confronted with the problem of power crisis. Installed capacity has also been increased manifold i.e. from 13.57 MW in 1950-51 to 12297.13 MW in 2012-13 but still the state suffers from severe power shortages which is -18.71 per cent at present (Pragati Prativedan). To overcome this deficit of power it is estimated that government has to allocate almost 42 per cent of its total budget outlay for the year 2014-15 (17th Electric Power Survey). An attempt has been made in the present study to highlight the problems of Rajasthan power sector and strategies to overcome it. No doubt the problem of power deficit could be overcome either by enhancing the supply or by curbing the excessive demand. But increasing the supply of power would not only aggravate the financial stress on government but would adversely affect the environment as more than 70 per cent of energy needs is met out from fossil fuel. Therefore Demand Side Management would be an effective option to tackle the problem of power deficit effectively and efficiently. In order to manage the power a critical factor to be studied is the pattern of consumption in different sectors and the factors strongly influencing it. Table 1.1 depicts the category wise load forecast for Rajasthan up to 2020.

Table 1.1
Category Wise Load Forecast for Rajasthan in Million Units

Year	Domestic	Commercial	Agriculture	Industrial	Others	Total
2005	3633.29	1068.63	5689.15	5358.96	1803.09	17553.93
2010	5338.49	1570.17	8359.23	7874.08	2650.52	25792.48
2015	8285.82	2264.56	10973.55	10935.77	3894.48	36354.19
2020	13962.09	3176.17	12968.37	13957.12	5722.27	49786.02

Source: 17th Electric Power Survey

The above table clearly brings out the fact that the consumption of power is likely to increase in all the sectors and if adequate efforts are not taken at the right time it would lead to the fall in the economic growth rate of the economy as the economic growth is determined by adequate supply of power. The increase in the consumption of power in residential sector is the highest (more than 300 per cent) this emphasizes the significance of research in DSM in residential sector.

2. Objective of the study

The primary objective of the study is to investigate the factors highly influencing the residential electricity demand in Jaipur city and to help the policy makers to frame effective and efficient DSM policies in order to overcome the problem of power deficit.

3. Methodology

Empirical analysis of the present study is based on primary data collected from 353 households using multistage random sampling technique in Jaipur city covering seven

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circle divisions and 32 sub circles. Multinomial Logistic Regression has been used since the household electricity consumption has been classified into four categories. Likelihood Ratio test has been performed to used to test the significance level of the 43 explanatory variables taken in this study.

4. Factors influencing Residential Electricity Consumption in Jaipur City

It has been observed in recent times that consumption of power in residential sector has been increased manifold as people prefer to use more of electrical appliances so as to have more leisure as well as lead a comfortable life. An attempt has been made in the present study to find out the factors highly influencing the residential electricity consumption in Jaipur city. The major factors contributing to increased consumption are identified and listed below in table 4.1.

Table 5.1: Variables and their acronyms
Dependent Variable: Monthly Household Electricity Consumption (MHEC) in KWh

Variables	Variables defined		Acronyms
Price of Electricity	Rising prices of electricity (Rs./KWh)	P	EFPEL
Household Characteristics	Monthly income of the household(Rs.)	H1	MINCOM
	Education level of the head of the household	H2	HHHEDU
	Age of the head of the household(Yrs)	H3	HHHAGE
	Sex of the head of the household(M/F)	H4	HHHSEX
	Type of the family	H5	FTYPE
	Size of the family	H6	FSIZE
	Religion of the household	H7	RELIGION
	Access to electricity in years	H8	LTEL
	Type of electricity connection	H9	PHEL
Stock of electrical appliances(23 in number)	Refrigerator	SE1	REFRG
	Star rated refrigerator	SE2	REFRG_S
	Geyser	SE3	GEYSER
	Star rated geyser	SE4	GEYSER_S
	Air conditioner	SE5	AC
	Star rated air conditioner	SE6	AC_S
	Electric stove	SE7	ELSTOV
	Ratio of incandescent to CFL	SE8	RINKCFL
	Aqua guard	SE9	AQUA
	Computer	SE10	COMPUT
	Immersion Rod	SE11	IMMROD
	Color Television	SE12	COLORTV
	Video Compact Disc	SE13	VCD
	Stereo player	SE14	STEREO
	Radio	SE15	RADIO
	Tape Recorder	SE16	TAPE
	Mixer and Grinder	SE17	MIXY
	Washing machine without drier	SE18	WASH
	Washing machine with drier	SE19	WASDRY
	Electric Water pump	SE20	ELWATPMP
	Iron box	SE21	ELIRON
	Hair drier	SE22	HARDRY
	Air cooler	SE23	AIRCOOL
Awareness towards energy conservation	Household's preference towards energy efficient appliances	EC1	PRFEE
	Household practice to conserve energy	EC2	PRKTSV
Structure of the dwelling	Built up area in square foot	SD1	BILTAR
	Age of the dwelling in years	SD2	AGEDWEL
	Age of the dwelling categorized	SD3	AGEDWEL_C
	Ownership of the dwelling unit	SD4	ONR
	Number of rooms	SD5	NROOM
	Number of doors	SD6	NDOOR
	Number of windows	SD7	NWINDOW
	Number of ventilators	SD8	NVNTLTR
	Interior color of the dwelling unit	SD9	KLRDWEL
	Insulation of the walls	SD10	WALINSU
	Trees planted	SD11	TREDWEL
	Detachment of the dwelling unit	SD12	DWLDTCH

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Various regressions have been run using Multinomial Logistic Model. Regression results indicate that all of the explanatory variables influences residential electricity consumption and out of them the results of the most significant variables have been reduced from 43 to 24 based on the results of Likelihood Ratio Tests and shown in table 4.1.

Table 5.13: Likelihood Ratio Tests (24 variables)
Dependent Variable: Monthly Household Electricity Consumption (MHEC) in KWh

Variables	Acronyms	Model Fitting Criteria			Likelihood Ratio Tests		
		AIC of Reduced Model	BIC of Reduced Model	-2 Log Likelihood of Reduced model	Chi-square	df	Sig
	Intercept						
Price of Electricity	EFPEL	747.416	1072.200	579.416	2.494	3	.476
Household Characteristics	MINCOM*	778.205	1079.789	622.205	45.282	9	.000
	HHHEDU*	750.296	1051.880	594.296	17.374	9	.043
	FTYPE	749.434	1074.217	581.434	4.511	3	.211
	LTEL	749.028	1073.811	581.028	4.106	3	.250
	PHEL	756.141	1080.924	588.141	11.218	3	.011
Stock of electrical appliances (10 in number)	REFRG	746.649	1071.432	578.649	1.727	3	.631
	REFRG_S	747.385	1072.168	579.385	2.463	3	.482
	GEYSER_S	755.699	1080.483	587.699	10.777	3	.013
	AC	750.161	1074.945	582.161	5.239	3	.155
	AC_S	760.892	1085.675	592.892	15.970	3	.001
	ELSTOV	751.529	1076.312	583.529	6.607	3	.086
	RINKCFL	747.123	1071.906	579.123	2.200	3	.532
	AQUA	749.765	1074.548	581.765	4.843	3	.184
	COMPUT	750.565	1075.348	582.565	5.643	3	.130
	IMMROD	747.155	1071.938	579.155	2.232	3	.526
Awareness towards energy conservation	PRFEE	746.263	1071.047	578.263	1.341	3	.719
	PRKTSV	776.190	1100.973	608.190	31.268	3	.000
Structure of the dwelling	AGEDWEL	748.748	1073.531	580.748	3.826	3	.281
	AGEDWEL_C	749.487	1074.270	581.487	4.565	3	.207
	ONR	750.637	1075.420	582.637	5.715	3	.126
	KLRDWEL	750.570	1075.353	582.570	5.648	3	.130
	TREDWEL	751.276	1076.059	583.276	6.353	3	.096
	DWLDTCH	750.718	1075.501	582.718	5.796	3	.122

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The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

Likelihood ratio tests (Table 4.1) indicate that out of 24 explanatory variables considered in the model five variables are significantly contributing to household electricity consumption at 1 percent or lower, one variable at less than 5 per cent and two variables 10 percent level of significance.

Findings of the present study

The parameter estimates given in table 4.1 shows that monthly income of the household is an important factor responsible for electricity consumption and as the income level rises, the per capita consumption of power would also rise rapidly. Hence DSM policies should be framed considering the rise in the future per capita income of the residents. Secondly it is seen from the study that rise in the educational level of the households has pushed down the residential electricity consumption. Educated people are very much aware about the energy saving techniques and their benefits therefore educational enlightenment of the households can definitely go a long way in curbing the excess demand and overcome the problem of power deficit. Increasing in the literacy rate (especially higher education) in our economy would not only help us to build a strong nation but also implement DSM policies more efficiently.

It is observed in the present study that practice of saving energy (PRKTSV) has a significant negative impact on the residential electricity consumption in Jaipur city. The people of the society should be encouraged to save energy either by some financial incentives or cut in tariff so as to curb excess demand for power. The present study clearly brings out the fact the use of energy efficient appliances among the households of Jaipur city has a significant impact on energy consumption. Since the city enjoys extreme summer and winter conditions the use of geysers and air conditioners are very common and therefore use of energy efficient/ star rated geysers, refrigerators and air conditioners would definitely a long way in curbing the demand for power and bringing a balance between the demand and supply of power. Policy makers should frame certain policies as to encourage the producers to manufacture the energy efficient appliances and make them available to public at reasonable rates.

Conclusion

It is found in the present study that all the variables have significant impact on the residential electricity consumption of Jaipur city. The findings of the study can help the policy makers to frame efficient Demand Side Management policies which would not only help the power sector of our economy to overcome the problem of power deficit but also reduce the financial stress of the government as increase in the installed capacity in the past few years to bridge the gap between growing demand and supply of power has resulted in mounting debts and also protect our environment from problems like global warming.

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