Relationship of Socio Economic Factors (SEF) and Energy Conservation Behavior in India: Empirical Study

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ABSTRACT

In this research paper focus of the researcher is to study the effects of various socio economic factors on energy conservation level. This study discusses the energy conservation behaviors of rural and urban households and existence of barriers towards energy efficient appliances and effects of socio economic factors on energy related behaviors in the households located in Ahmednagar District, sample size was 567 households. The survey was conducted with help of structured questionnaire, and telephonic replies. Our result indicates that residence, education, religion and ownership of households are the major factors that have considerable effect on level of energy conservation behavior. We have tested hypothesis about all other factors and their relationships, an attempt has been made to predict the level of energy conservation by using multinomial logistic regression method. Particularly we want to find solution for questions like 'how socio economic factors play its role in determining energy demands?' 'What are the barriers for energy conservation?' 'Can we predict energy conservation behavior?'

Keywords: Energy conservation, Socio-economic Multinomial, Relationship, Empirical

Introduction-

In this study we have considered factors like age, gender, income, location, marital status, profession, education, No. of rooms, ownership of the house, field of study and religion.

Multinomial logistic regression was used for finding out the significant effect of independent variables on dependent variable which is energy conservation level measured in three levels as Low, Moderate and High.

In India residential sector contributed to 25% of the total electricity consumption in 2011. Lighting and major appliances like ceiling fans, televisions, refrigerators and air-conditioners account for about 80% of the residential electricity consumption. The rest comes from smaller and lesser used appliances like washing machine, geysers, computers etc.(NITI Aayog, 2015) Appliance ownership is significantly increasing both in rural and urban households due to rise in income levels and consumerism. The residential sector accounts for one-fifth of global energy consumption, resulting from the requirements to heat, cool, and light residential dwellings. It is therefore not surprising that energy efficiency in the residential market has gained importance in recent years. (Brounen, D., Kok, N., & Quigley, J. M., 2013). In their study they examined the awareness, literacy and behavior of households with respect to their residential energy expenditures. They measured the extent to which consumers are aware of their energy consumption and whether they have taken measures to reduce their energy costs. They found that, consumer attitudes towards energy conservation, depends on the demographics but not energy literacy and awareness and have direct effects on behavior regarding heating and cooling of the home. Energy consumption in itself is not behavior, but it's a consequence of behaviors, such as turning the lights off or lowering thermostat levels (Becker *et al.* 1981). There is relationship between energy consumption level and income levels, Lifecycle stage and ethnicity have been identified (EIA 2009a; Hackett and Lutzenhiser 1991; Lutzenhiser 1993; O'Neill and Chen 2002). The root of modern prosperity can be found in the application of mass production technology, together with excess capital and a free market to exploit such technologies. This phenomenon is not favorable for sustainable development, of any economy. Developing countries like India need to save energy because it improves its global competitiveness and position in energy security.

Review of Literature -
Some of the relevant research work has been summarized,

Fred A. Curtis et.al., 1984, this study assesses the influence of attitudinal and socio-economic factors on household energy conservation actions. A household interview survey in Regina, Saskatchewan found that respondents perceive an energy problem, although no association with energy conservation actions was determined. Two attitudinal and five socio-economic variables influenced household energy conservation.

Manfred Lenzen et.al., 2006,this paper is study of sustainable household consumption from a global perspective. Use per capita energy requirements as an indicator of environmental pressure focus on the importance of income growth in a cross-country analysis. It bring together family expenditure survey data, input–output tables, and energy statistics in a multivariate analysis

Eleni Sardianou, 2007, this paper develops an empirical model to investigate the main determinants of household energy conservation patterns in Greece employing cross-section data. In the empirical analysis, household energy-conserving choices models are employed, using a discrete and a latent trait variable respectively as a dependent variable. The results show that socio-economic variables such as consumers' income and family size are suitable to explain differences towards energy conservation preferences. In addition, the results suggest that electricity expenditures and age of the respondent are negatively associated with the number of energy-conserving actions that a consumer is willing to adopt.

Wokje Abrahamse, Linda Steg, 2009, the study examined the relative importance of socio-demographic variables and psychological variables in relation to household energy use and changes in energy use. Results indicate that energy use is determined by socio-demographic variables, whereas changes in energy use, which may require some form of (cognitive) effort, appear to be related to psychological variables.

Eva Heiskanen et. al., 2010, paper analyses different types of emerging low-carbon communities as a context for individual behavioural change. The focus is on how these communities offer solutions to problems in previous attempts to change individual behaviour. These problems include social dilemmas, social conventions, socio-technical infrastructures and the helplessness of individuals. Different community types are examined, including geographical communities as well as sector-based, interest-based and smart mob communities.

John Thøgersen, Alice Grønhøj, 2010, the results suggest two approaches to promote electricity saving in households, first to change the socio-structural environment to be more facilitating for energy saving and empower householders to be more effective in their striving towards this goal through improved feedback about their household's electricity consumption and second social norms marketing, communicating social expectations and others' successful electricity saving achievements.

Geun Young Yun, Koen Steemers, 2011, as global warming continues, the current trend implies that the uptake of air conditioning in the residential sector will go up, thus potentially increasing domestic cooling energy consumption. In this context, this paper investigates the significance of behavioural, physical and socio-economic parameters on cooling energy in order to improve energy efficiency in residential buildings. It demonstrates that such factors exert a significant indirect as well as direct influence on energy use, showing that it is particularly important to understand indirect relationships.

Steg Linda, 2008, In this study barriers to energy conservation are discussed, they are insufficient knowledge of effective ways to reduce household energy use, the low priority and high costs of energy savings, and the lack of feasible alternatives, the paper elaborates on the effectiveness and acceptability of strategies aimed to promote household energy savings. Informational strategies aimed at changing individuals' knowledge, perceptions, cognitions, motivations and norms, as well as structural strategies aimed at changing the context in which decisions are made, are also discussed.

The concept of energy efficiency is broadly used in the fields of energy, economics, and environment, and what is more has had emerged as one of the most cost-effective methods in conserving and saving energy and lessening emissions of greenhouse gas. Studies have confirmed both in quantitative and qualitative results (Yang et al, 2014). However, the market penetration of energy efficient technologies is generally hindered by barriers that are effected by prices, financing, international trade, structure of market institutions, information provision and socio-cultural and behavioral issues. There are other barriers in the forms of convenience and inertia of the status quo that forces solution providers technology providers developing energy conservation devices, leading to persistent high energy consuming appliances in both urban and rural households (Ramesh, Khan,2013).

Objectives:-
The aim of this study is to conduct in-depth analysis of relationship of socio economic factors and the level of energy conservation behavior in urban and rural households, also wants to identify what are the barriers to efficient energy use among rural and urban households in India.
Following are the research objectives,

1. To evaluate the effect of socio economic factors on energy conservation practice.
2. To identify the barriers to efficient energy use in the households.
3. To predict energy conservation behavior

Methodology-

Research Method- Quantitative

Design- Descriptive & Exploratory

For Primary data- collected from households situated in the area under study.

Questionnaire Method –Semi structured questions for Survey. Personal Interviews –Direct and Telephonic, Observations, Expert Opinion from head of households.

Questionnaire method:
A schedule (questionnaire) was used as a research instrument to collect primary data. The schedule consists of combination of open and close ended questions. Five point and Seven point Likert scale are used to record the responses.

For Secondary data –
CMIE database, TERI reports, Bureau of Energy Efficiency reports. Bureau of Energy Efficiency reports, PCRA study reports. NCAER Reports, Ministry of Power, UNO papers, Research Papers published in referred journals, MEDA study reports.

For Data Analysis -
Testing the Hypothesis- Chi square, Multinomial Logistic regression with Software: SPSS 18.00

Sample Design
Sampling Method: Sampling design was prepared so as to draw a representative sample from the population and reach reliable conclusions.

Universe-   Households in Ahmednagar District.
Sample frame-   Housing profile census 2011 (Govt. of India)

Sample Unit-   Households
Defined-   Rural area as- population below 7000 & Urban >7000
Type of sampling –   Probability type, multistage sampling, area sampling plan
Sample size-   567 households

Table No.01- DEMOGRAPHIC DETAILS		Location		
		Rural	Urban	
		Count	Count	**Total**
gender	male	394	94	488
	female	39	40	79
marital status	married	380	115	495
	unmarried	53	19	72
age of respondent	18-29	78	29	107
	30-39	140	55	195
	40-49	135	40	175
	50-59	57	9	66
	above 60 yr	23	1	24
religion	hindu	304	120	424
	muslim	30	6	36
	christian	8	3	11
	buddhist	54	4	58
	others	37	1	38
total members staying in the household	1-2 members	38	7	45
	3-4 members	240	103	343
	5-6 members	107	18	125
	7-8 members	42	5	47
	More than 8	6	1	7
profession of the respondent	farmer	126	4	130
	pvt-service	135	75	210
	business	64	22	86
	govt. service	13	8	21
	others	95	25	120
monthly income of households	Less than 5000	285	20	305
	5000-10000	112	47	159
	10001-30000	31	41	72
	30001-50000	2	22	24
	More than 50000	3	4	7
number of rooms in house	1-2 rooms	225	50	275
	3-4 rooms	181	74	255
	5-6 rooms	26	8	34
	7-8 rooms	0	1	1
	More than 8 rooms	1	1	2
ownership of house	owner	386	101	487
	on rent	46	30	76

	other	1	3	4
monthly bill of electricity	Rs 50-100	186	4	190
	Rs 101-300	185	27	212
	Rs 301-500	44	56	100
	Rs 501-1000	14	40	54
	Rs 1001-3000	4	7	11
education of the respondent	SSC	89	24	113
	HSC	59	21	80
	DEGREE	34	44	78
	PG	20	32	52
	Others	231	13	244
field of study at graduation	arts	71	29	100
	commerce	29	23	52
	science	21	36	57
	engineering	3	9	12
	Others	309	37	346
	Total	**433**	**134**	**567**

Data Analysis and Results-
"To evaluate the effect of socio economic factors on energy conservation practice"
The multinomial logistic regression was performed to test the effect of socio economic factors on energy conservation level and for predicting the energy conservation level of lower saver, moderate or higher saver with reference to SEF factors.

Result: Multinomial logistic regression was conducted with dependent variable with three categories of energy conservation level for 567 households. We can also study the association of socio economic factors with the conservation level. After studying this phenomenon, it is observe that independent variables –resident, religion, education, ownership have significant associations with energy conservation level.

After applying multinomial logistic regression, the model fitting shows as per Table No. 02 and 03, it is significant (Sig. value < 0.000), also the model can explain 23.8% variance (Nagelkerke). Overall prediction accuracy is 60.3%. Null hypothesis is "regression coefficients are equal to zero" The table of parameter estimates explains the odds ratio Exp (B) for the dependent variable energy conservation level. The odds ratio for household with religion (Hindu) has 16.11 times, likelihood of coming in higher category over lower category; it is significant association with OR>1. The odds ratio is 17.3 times for Buddhist to be in higher category over lower with it is significant association with OR>1. The odds ratio for household with location (rural) has 3.5 times, likelihood of not coming in higher category over lower category; it is OR<1. The odds ratio for household with education (PG) has 4.9 times, likelihood of coming in higher category over lower category; it is significant association with OR>1. The odds ratio for household with religion (Muslim) has 7.2 times, likelihood of coming in higher category over lower category; it is significant association with OR>1. The odds for households with profession of head of household (business) have 2.04 times likelihood of coming in higher category over lower, it is not significant with OR>1.

Table No.02- Model Fitting Information						
Model	Model Fitting Criteria			Likelihood Ratio Tests		
	AIC	BIC	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	545.058	553.738	541.058			

Table No.02- Model Fitting Information					
Model	Model Fitting Criteria			Likelihood Ratio Tests		
	AIC	BIC	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	545.058	553.738	541.058			
Final	474.481	613.372	410.481	130.577	30	.000

Table No.03-Parameter Estimates									
Dependent three categories of Energy Conservation Level 1-Low, 2-Moderate, 3- High		B	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)		Sig.
							Lower Bound	Upper Bound	
HIGH	[ownership=1]	-16.429	1592.693	1	.000	.000	.000	.000	*
HIGH	Intercept	15.050	251.006	1	.000				*
HIGH	[religion=1]	2.780	12.380	1	.000	16.113	3.425	75.795	*
HIGH	[religion=4]	2.849	11.121	1	.001	17.265	3.236	92.103	*
HIGH	[resident=1]	-1.255	6.697	1	.010	.285	.110	.738	*
HIGH	[education=4]	1.591	5.238	1	.022	4.910	1.257	19.183	*
HIGH	[religion=2]	1.984	4.193	1	.041	7.271	1.089	48.558	*
HIGH	[education=2]	-.727	2.849	1	.091	.483	.208	1.124	ns
HIGH	[profession=3]	.713	2.217	1	.136	2.039	.798	5.211	ns
HIGH	[education=1]	-.539	1.916	1	.166	.584	.272	1.251	ns
HIGH	[profession=1]	.584	1.795	1	.180	1.793	.763	4.212	ns
HIGH	[education=3]	.552	1.187	1	.276	1.737	.643	4.693	ns
MODERATE	[religion=1]	1.890	19.426	1	.000	6.619	2.856	15.338	*
MODERATE	[resident=1]	-1.557	12.593	1	.000	.211	.089	.498	*
MODERATE	[religion=2]	1.885	10.386	1	.001	6.586	2.093	20.726	*
MODERATE	[religion=4]	1.031	3.727	1	.054	2.803	.984	7.978	ns
MODERATE	[religion=3]	1.244	2.273	1	.132	3.471	.688	17.500	ns
MODERATE	[education=2]	-.467	1.779	1	.182	.627	.316	1.245	ns
Reference category- Low (1), ns= non significant , * = significant association									

"Energy Conservation level is depends on socio economic factors of households"
We are using Chi-square test for identifying relationship between socio economic factors and the energy conservation level.
H1 (null): There is no significant relationship between energy conservation level and socio economic factors
H1: There is a significant relationship between energy conservation level and socio economic factors
Dependent Variable: Energy conservation level (1= Lower, 2=Moderate, 3= Higher)
Independent variables: Socio economic factors

Table No.04- Relationship of ECL and SEF						
Variable	Lower saver	Moderate	Higher saver	Chi	P	Sig.

				square (df)	value	
Gender	Male =20.9% Female =13.9%	Male =55.5% Female =49.4%	Male =23.6% Female =36.7%	(2, N=567) =6.759	0.034	*
Marital	Married =21.4% Unmarried =9.7%	Married =54.5% Unmarried =55.6%	Married =24% Unmarried =34.7%	(2, N=567) =7.14	0.028	*
Location	Rural=24.2% Urban=6.0%	Rural=52.2% Urban=62.7%	Rural=23.6% Urban=31.3%	(2, N=567) =21.6	0.000	*
Age	Above 60 =25.0% 18-29=11.2%	50-59=62.1% 30-39=51.8%	18-29 =30.8% 50-59=19.7%	(8, N=567) =11.0	0.2	ns
Religion	Others =65.8% Hindu=14.6%	Muslim=66.7% Other=28.9%	Buddhist=34.5% Hindu=27.4%	(8, N=567) = 69.3	0.000	*
Members in house	5-6 =23.2% More than 8= 0%	>than 8=85.7% 5-6= 49.6%	5-6=27.2% >than 8=14.3%	(8, N=567) = 9.3	0.315	ns
Profession	Others =30.0% Pvt Service=15.7%	Pvt serv=57.6% GovServ=47.6%	Govt serv=28.6% Others =19.2%	(8, N=567) =11.8	0.161	ns
Income	<5000= 23.6% >50000=0%	5000-10000=59.7% >50000=28.6%	>50000=71.4% 5000-10000=20.8%	(8, N=567) = 25.7	0.001	*
No of rooms	>8 rooms=50% 7-8 rooms=0 %	7-8 rooms =100% >8 rooms= 0%	>8rooms = 50% 7-8 rooms= 0%	8, N=567) = 23	0.003	*
Ownership	Rent =32.9% Owner=18.1%	Owner= 56.1% Rent =48.7%	Owner=25.9% Rent =18.4%	(4, N=567) = 21.17	0.000	*
Monthly Bill electricity	100-300= 26.4% >1000=0%	50-100= 57.4% 501-1000=51.9%	1001-3000=45.5% 50-100= 22.6%	(8, N=567) = 20.2	0.010	*
Education	HSC= 25% Degree = 11.5%	SSC=61.9% PG=38.5%	PG= 55.8% SSC= 17.7%	(8, N=567) = 41.3	0.000	*
Field of education	Arts = 24.4% Engg=8.3%	Engg= 66.7% Arts =50.0%	Science =42.1% Others =21.1%	(8, N=567) = 18.9	0.015	*
* means significant relationship, ns-non-significant relationship						

Source: Primary data

From Table No.04, as per analysis of data using chi-square for independence, the variables Location, gender, marital status, religion, Income, No of rooms, ownership, monthly bill of electricity, education and field of education have significant association with the energy conservation level. Variables like Age, Members in house, Profession does not associated with energy conservation level

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Result: Null hypothesis is rejected, which means socio economic factors have relationship with level of energy conservation.

Conclusion and Scope for further research -
Some factors like socio economic factors, behavioral factors, market conditions and government policies are associated with household's level of energy conservation. It was observed that, urban households have shown positive behavior towards energy conservation, than rural households. Barriers are prominent in case of urban households because they do not want to compromise on level of comfort; do not like to change the behavior, not worried about consequences. As per analysis of data for testing association between socio economic status and energy conservation behavior, we found that the variables like location, gender, marital status, and religion, Income, number of rooms, ownership, and monthly bill of electricity, education and field of education have significant association with the energy conservation level. But some variables like age, number of members in the house, profession of the head of household does not associated with the energy conservation level. Understating consumer behavior is one of the difficult fields of research, in that study of energy conservation behavior is even more complex. The difficulties faced while determining and finalizing the factors, which have some impact on our energy conservation behavior. There are two methods we can implement to minimize the use of energy in household, one is curtailment of the energy wastage while using it, it is basically related to the individual consumer behavior which is affected by sociological and psychological factors. It depends on habits like turning off lights, fans on a frequent basis in the household while not allowing any kind of energy wastages. Another method is the use of energy efficient appliances and improvement of efficiency of energy use through technological improvement, up gradation and it requires investments in energy efficient devices. Since energy conservation is the most cost effective solution for economic development of a nation in sustainable way, further studies can focus on estimating actual monetary benefits of pro environmental behaviors.

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