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Adoption of Green Energy in Rural India: Inquisition and Remedies

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ABSTRACT

Sustainable development is a policy makers' everlasting challenge which aims at balancing economic, societal and environmental demands in present context without compromising the future requirements. The environmental challenges have increased manifold with the increasing pace of economic enterprise and social demands. Wood as fuel energy used by a large plethora of population is considered as a major contributor to depletion of forest cover in rural India. The visible impact of using wood as fuel energy ranges from creation of health hazards due to smoky kitchens in short run to climatic changes due to deforestation in the longer time span. The alarming consequences related with unbalanced forest usage led to growth of concept of green energy across the world which is largely underlined by environmental concerns, economic benefits and government led market mechanisms which facilitate its usage and marketing through incentives and subsidies. National Policy of Bio Fuels of India aims at increasing its market availability for increased consumption. The present paper makes an attempt to revisit one of the concepts of green revolution namely green energy.

The present paper is an empirical study which aims at analyzing (i) the rural house hold consumption of fuel (ii) Reasons for using a Particular fuel (iii) Factors influencing the adoption of green energy in Bastar and Raigarh districts of Chhattisgarh. The data was collected from 250 respondents from each district and was analyzed using SEM to draw meaningful conclusions.

It was found that health benefits, enhanced income, ease of operation were the major reason for adoption of green energy.

Keywords: Sustainable development, Bio Fuels, Fuel Enrgy, Green energy, Adoption of Green Energy.

INTRODUCTION:

Energy consumption is an important facet of human routine. It plays an important role in completing the basic activities related with daily chores. In recent decades policy makers in India have made an attempt to understand and manage the impact of energy consumption using sustainable practices. It was evidently seen by policy makers that majority of the rural household along with people below poverty lines in urban and semi urban areas in India are still dependent on traditional sources of fuel like firewood, coal, dung – cakes etc to meet their daily fuel requirement. Ministry of Petroleum and Natural Gas (2018) highlighted the sincere efforts made by government to India to provide access to the financially marginalized groups of people to green energy. The Pradhanmantri ujjwala yojna presently covers 712 district and has provided LPG connections to 3, 26,

14,226 beneficiaries since its inception.

The adoption of green energy in rural India to promote sustainable changes poses economical as well as social changes in the life of villagers who have strong resistance to change. Winkler (2007) highlighted that energy plays a dominant role in sustainable socio economic development therefore it has become increasingly essential for policy makers to understand the impact of proposed changes in the lives of larger base of population and make policies to benefit them in the long run. Magilindane (2003) opined that energy consumption is directly related with quality of life. He indicated that the improvement in quality of life will demand higher consumption of affordable and sustainable energy which will have an impact on disposable income available for fulfillment of economic needs. Further, Tessama et.al. (2013) identified the correlation between access to affordable energy for fulfillment of basic needs and the level of economic development taking place in a country. His research indicated that residents of lesser developed countries have lesser access t affordable energy therefore they are largely dependent on traditional sources of energy which is casting a harmful effect on environment in terms of pollution and forest cover depletion.

Sustainable development is a policy makers' everlasting challenge which aims at balancing economic, societal and environmental demands in present context without compromising the future requirements. The environmental challenges have increased manifold with the increasing pace of economic enterprise and social demands. Chicombo (2015) highlighted that the dramatic rise of population along with increasing economic enterprise in developing and underdeveloped countries has resulted in deterioration in the quality of air due to no or little policy related with energy security and its consumption. Wood as fuel energy used by a large plethora of population is considered as a major contributor to depletion of forest cover in rural India. Madubansi and Shackleton (2007) highlighted that after centuries of civilization growth wood remains the primary source of energy for meeting the routine domestic energy requirement in almost all developing counties. Macht et.al (2007) reflected that the world rate of deforestation has reached alarming figures of about 13 million hectares per year which is causing imbalance in the environment. The visible impact of using wood as fuel energy ranges from creation of health hazards due to smoky kitchens in short run to climatic changes due to deforestation in the longer time span.

The alarming consequences related with unbalanced forest usage led to growth of concept of green energy across the world which is largely underlined by environmental concerns, economic benefits and government led market mechanisms which facilitate its usage and marketing through incentives and subsidies. National Policy of Bio Fuels of India aims at increasing its market availability for increased consumption. Andadari et. al. (2014) highlighted that access and adoption of affordable green energy will help in solving the basic problems related with deforestation and poverty alleviation in the developing counties all over the world. Further millennium development goals have highlighted the need for sustainable development and researchers have emphasized on affordable green energy for meeting the requirements of the three fundamentals of sustainable development namely economic, social and environmental in a balanced form. Balachandra (2012) and Sachs (2012) highlighted that adoption and diffusion of modern green energy carriers will ensure sustainable development in future.

Energy consumption in rural and urban areas is majorly governed by socio economic status of the user. The consumers residing in rural areas are dependent on traditional sources of energy as it is accessible and economical on the other hand people residing in urban and semi urban areas migrate from traditional fuels to modern fuels with increase in income and change in life style. Hence, the researchers have noted that accessibility and cost plays an important role in the choice of fuel for energy. WHO (2006) indicated that rural population across the globe is dependent upon bio mass fuels (fire wood, cow dung and crop residue etc) to meet their domestic energy requirement due to accessibility and affordability. Spalding- Fecher et.al. (2005) provided the reference conclusions of world summit on sustainable development organized in 2002 to highlight the importance of clean fuel and development of policy guidelines for adoption of clean and green fuels. Balchandra (2011) identified that inadequate physical access, inadequate physical availability, inadequate acceptability; inadequate affordability and inadequacy of resources were the major reasons for slow adoption and diffusion of green energy.

In recent times a host of researches have been conducted by researchers to understand the elements which will ensure the development of an adequate policy for use of green energy in rural areas. Magilindane (2003) opined that sustainable green energy policy must encompass following parameter like (i) increased access to affordable green energy, (ii) improved energy sector governance (iii) encouraging economic development (iv) Management of Energy related environmental impacts and (v) sourcing energy supply through grater diversification. In the above backdrop the researchers have tried to identify following issues:

(i) The rural house hold consumption of fuel
(ii) Reasons for using a Particular fuel
(iii) Factors influencing the adoption of green energy

Table 1: Fuel Wood Usages in India

State/UT	No of Persons using Fuel Wood (millions)	No of Persons using Fuel Wood from Forest (million)	Quantity of Fuel Wood used (million tonnes)	Quantity of Fuel Wood used from Forest (million tonnes)
Andhra Pradesh	64.992	7.573	24.293	2.966
Arunachal Pradesh	0.882	0.698	0.402	0.325
Assam	23.373	5.812	11.421	2.494
Bihar	65.816	3.115	11.475	0.465
Chhattisgarh	20.078	7.818	4.366	1.378
Gujarat	40.092	7.497	9.731	2.225
Haryana	8.092	0.012	1.494	0.003
Himachal Pradesh	5.912	5.646	1.214	1.163
Jammu and Kashmir	8.375	4.540	1.394	1.015
Jharkhand	21.733	9.984	4.844	2.849
Karnataka	44.681	9.584	20.967	5.776
Kerala	29.504	4.429	14.543	2.183
Madhya Pradesh	51.007	24.839	13.665	7.191
Maharashtra	68.904	31.845	9.508	4.527
Orissa	33.029	11.110	8.894	2.971
Punjab	13.628	0.136	3.348	0.029
Rajasthan	57.992	11.414	18.782	3.698
Tamil Nadu	42.405	7.429	12.387	2.601
Uttar Pradesh	175.096	10.495	19.063	1.294
Uttarakhand	7.289	6.060	2.566	2.139
West Bengal	51.202	18.574	14.158	6.361
North Eastern States	9.383	6.588	5.274	3.822
UTs	10.412	4.432	2.633	1.272
Grand Total	**853.879**	**199.631**	**216.421**	**58.747**

Source: India State of Forest Report, 2011, available at https://data.gov.in/catalog/annual-fuel-wood-consumption

RESEARCH METHODOLOGY:

The researchers have collected data from 500 respondents residing in rural areas of Bastar and Raigarh district Chhattisgarh. 50 respondents were randomly selected from Adawal, Bakel, Deoda, Surapal and Taragaon villages of Bastar district which accounted to a total 250 respondents. Further 50 respondents were randomly selected from Arspali, Bhatpur, Baluabahar, Gholeng and Kotara villages of Raigarh district which accounted to a total 250 respondents. The data was collected with the help of a schedule and was analysed with the help of SPSS. The researchers formulated following hypotheses to test respondents' attitude and adoption intention using structural equation modeling:

H_1: There is significant relationship between affective factors (AFF) and the respondents' attitude towards green fuel (ATGF).

H_2: There is significant relationship between cognitive factors (COGF) and the respondents' attitude towards green fuel (ATGF).

H_3: There is significant relationship between behavioural factors (BEF) and the respondents' attitude towards green fuel (ATGF).

H_4: There is significant relationship between respondents' attitude towards green fuel (ATGF) and adoption of green fuel (ADOP).

DATA ANALYSIS AND INTERPRETATION:

Multiple Response Analysis:

Table 2.1: Case Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
$Q1[a]	500	100.0%	0	0.0%	500	100.0%
a. Dichotomy group tabulated at value 1.						

It is found from the Table No. 2.1 that 500 respondents gave their answers with respect to fuel used for cooking. Those 500 people, who answered, ticked 1516 responses in total as shown in table 2.2. That is an average of slightly more than 3 per respondent. All the respondents said that they use "firewood" for cooking which has highest score of 100% and share of 32.98% among all responses, followed by "kerosene" (score 82% and share 27.04%), "animal waste" (score 48.4% and share 15.96%), "charcoal" (score 47.2% and share 15.56%), "Crop residual"(score 9.6% and share 3.16%), "LPG" (score 9.2% and share 3.03%), "electricity" (score 6.8% and share 2.24%), respectively.

Table 2.2: Major Fuel Used by Villagers

		Responses		Percent of Cases
		N	Percent	
Which fuel you use for cooking ?[a]	Firewood	500	32.98%	100.0%
	Kerosene	410	27.04%	82%
	Animal waste	242	15.96%	48.4%
	Charcoal	236	15.56%	47.2%
	Crop residual	48	3.16%	9.6%
	LPG	46	3.03%	9.2%
	Electricity	34	2.24%	6.8%
Total		**1516**	**100.0%**	**303.2%**
a. Dichotomy group tabulated at value 1.				

It is found from the Table No. 2.3 that 500 respondents gave their reason to use current fuel they are using. Those 500 people, who answered, ticked 1780 responses in total. That is an average of slightly more than 3 per respondent. All the respondents are answered that due to "convenience" and "affordability" they are using current fuel which has highest score of 100% and share of 28.08% among all responses, followed by "accessibility" (score 96% and share 26.96%), "ritual" (score 60% and share 16.85%) respectively.

Table 2.3: Reason for usage of current fuel

		Responses		Percent of Cases
		N	Percent	
Why you use current fuel? [a]	Convenience	500	28.08%	100.0%
	Affordability	500	28.08%	100.0%
	Accessibility	480	26.96%	96%
	Ritual	300	16.85%	60%
Total		**1780**	**100.0%**	**356.0%**
a. Dichotomy group tabulated at value 1.				

It is found from the Table No. 2.4 that 500 respondents gave their reason that why they would like to use bio gas or solar power in future. Those 500 people, who answered, ticked 1238 responses in total. That is an average of slightly more than 2 per respondent. Respondents who answered that they would like to use bio gas or solar power in future to "save forest wood" which has highest score of 76% and share of 30.69% among all responses, followed by "save time of collecting forest wood" (score 42% and share 16.96%), "reduces smoke" (score 38.8% and share

15.67%), "save time in cooking" (score 32% and share 12.92%), "government subsidy" (score 30.2% and share 12.19%), "generation of additional income due to saved time" (score 28.6% and share 11.55%), respectively.

Table 2.4: Intention to use bio gas or solar power in future

		Responses		Percent of Cases
		N	Percent	
Why you would use bio gas or solar power in future? [a]	Save forest wood	380	30.69%	76%
	Save time of collecting forest wood	210	16.96%	42%
	Reduces smoke	194	15.67%	38.8%
	Save time in cooking	160	12.92%	32%
	Government subsidy	151	12.19%	30.2%
	Generation of additional income due to saved time	143	11.55%	28.6%
Total		**1238**	**100.0%**	**366.0%**
a. Dichotomy group tabulated at value 1.				

It is found from the Table No. 2.5 that 500 respondents gave their answers that why they do not use bio gas or solar power. Those 500 people, who answered, ticked 1830 responses in total. That is an average of slightly more than 3 per respondent. All the respondents answered that due to 'additional cost of purchase and installation" they are not using bio gas or solar power which has highest score of 100% and share of 27.3% among all responses, followed by "lack of awareness" (score 96% and share 26.2%), "lack of information about government schemes" (score 80% and share 21.9%), "fear of technical expertise" (score 60% and share 16.4%), "pressure of family" (score 22% and share 6%), "cultural and social barriers" (score 8% and share2.2%) respectively.

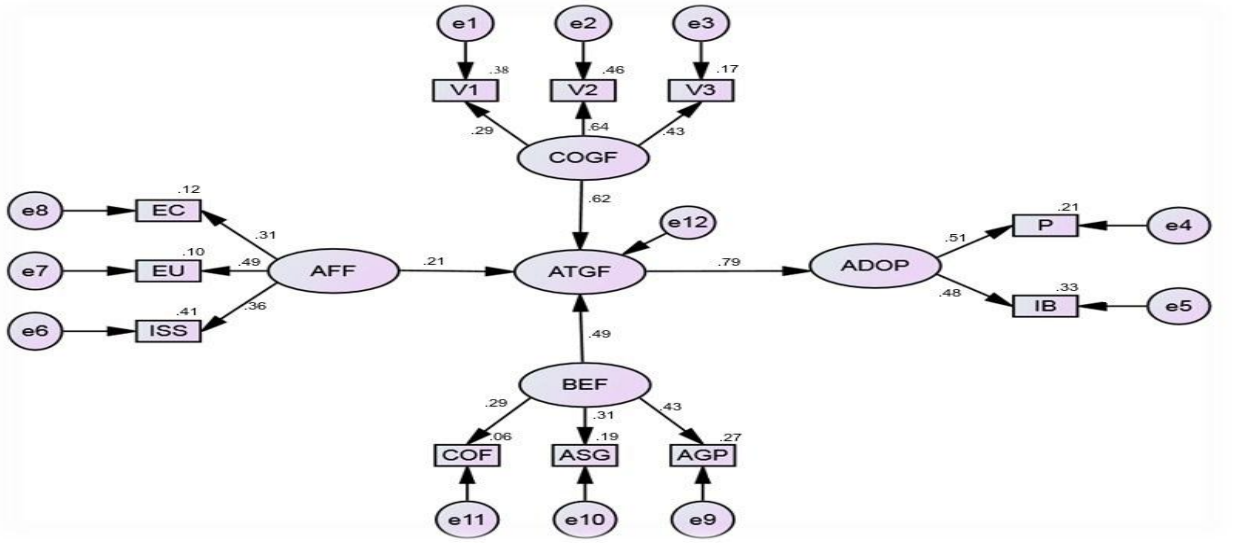
Table 2.5: Reason for not using Bio Gas or Solar Power

		Responses		Percent of Cases
		N	Percent	
Why you do not use bio gas or solar power? [a]	Additional cost of purchase and installation	500	27.3%	100.0%
	Lack of awareness	480	26.2%	96.0%
	Lack of information about government schemes	400	21.9%	80.0%
	Fear of technical expertise	300	16.4%	60.0%
	Pressure of family	110	6.0%	22.0%
	Cultural and social barriers	40	2.2%	8.0%
Total		**1830**	**100.0%**	**366.0%**
a. Dichotomy group tabulated at value 1.				

Structural Equation Modelling:

As suggested by Andreson and Gerbing (1992) the researchers first conducted confirmatory factor analysis (CFA) and identified goodness- of- fit indices than research model was tested by researchers through structural equation modeling (SEM) using AMOS 21 software to identify the relationship between constructs. All means were above the midpoint of 3.00. The standard deviations range from .68 to .83 which indicates narrow spread around the mean. The skewness (ranges from -.42 to .16) and kurtosis (-.61to .19) indices were found normal as per the recommendation of Kline (2005). The structural model was found reliable and valid as composite reliability of all construct variables were above 0.70 which is indicative of good scale reliability as per the rule of thumb suggested Hair et al., (2010); Nounally and Bernstein (1994). Discriminant validity of all the constructs were above .82 and average variance extracted were between .66 to .89 which were found good according to the guidelines of Hair et al., (1998).

Figure 1: Standardised Structural Model tested by researchers



(Chi-square = 27.632, df= 14, GFI= .910, NF = .912, IFI = .924, TLI= .907, RMSEA= .61, Chi-square / df = 1.973)

All the values of these fit indices indicate good model fit according to Kline (2005); Browne and Cudeck (1992).

Table 3: Hypothesis Testing Results and Structural Model estimates

Path Coefficient			Estimates	S.E.	C.R.	P	Standardised Estimates	Result
ATGF	<---	AFF	.317	.104	-.468	.749	..21	Not Supported
ATGF	<---	COGF	.946	.831	2.193	***	.62	Supported
ATGF	<---	BEF	.825	.947	2.014	***	.49	Supported
ADOP	<---	ATGF	.964	.512	2.317	***	.79	Supported

Keeping in view the guidelines of Hair et al., (2010) and critical ratios the hypotheses were tested. It was found that affective factors do not play any role in formation of respondent's attitude towards green fuel. It was also inferred that cognitive factors and behavioural factors play significant role in formation of respondent's attitude towards green fuel and further this attitude intend them to adopt green fuel.

IMPLICATIONS OF THE STUDY:

The constant depletion of forest cover in contrast to its recoupment has emerged as a major concern in recent times. The policy makers are apprising alternatives for a diverse country like India to minimize the threats posed by scarcity and effects of fossil fuels created by its rampant usage. The present study highlights the factors which can influence a favorable attitude of rural Indian population towards green fuels in comparison to the traditional fuels used by them. The attitude study of the respondents highlighted that the adoption and diffusion of green fuels faces following barriers in rural India:

Economic barriers:
the usage of green fuels is costly in comparison to fuel wood, animal waste and crop residue in rural India. Thus the adoption of green fuel difficult in rural population who are price sensitive due to limited disposable income in their hands to meet their needs.

Technical barriers:
the adoption of green fuels will require creation of new modified infrastructure and procurement of equipments for usage by the adopters in rural India. The literacy levels and economic investment in technology is an area for grave concern for policy makers.

Social barriers:
the social gatherings of women while collecting fuel wood or making cow dung cakes is part of rural life. It is difficult for rural women to change their social way of life and find alternative time for their discussions.

Knowledge barriers:
there is lack of awareness amongst the rural population regarding the policies and subsidies given by government for promotion and usage of green fuels. The governmental policies needs to be highlighted and proper information dissemination mechanism should be formed.

The present study has highlighted that the cognitive and behavioral aspects of attitude model were responsible for formation of positive attitude towards the adoption of green fuels. The cognitive factors like: healthy in use, enhanced income, easy to operate; behavioral factors like concern for family, affiliation to social group, appreciation of government plans were factors influencing the adoption of green fuels in the selected villages of Bastar and Raigarh. The findings can be used as generalizations to formulate policies by policy makers for proper adoption and diffusion of green fuels. The governmental agencies must take measures to influence the villagers both at explicit and implicit levels. The policy makers must ensure that self consciousness is developed in the minds of villagers to safeguard the environment and they reduce the use of traditional fuels voluntarily. The explicit measure of self reporting amongst villagers will bring down the consumption of traditional fuels and increase the usage of green fuels. Further implicit factors like care for family and efforts for a better life can be translated as factors like health benefits, enhanced income and ease of operation for adoption of green energy. Further the scope of the study can be further enhanced for generalization of the findings of the research. The study provides a general outlook towards green fuel. The future researchers can conduct a niche study for individual traditional and green fuels which will provide a better spectrum for policy making. The study is limited to its research objectives but the researchers during the course of study understood that the fuel requirement is different for rural and urban area thus a similar prescription cannot be provided for the problem of adoption of green fuels. The grave challenge of adoption and diffusion of green fuels must be catered at different levels according to needs. The development of specific bio fuel policy and its practical implementation will surely become an important step to make a sustainable environment by conscious efforts and change in life style and practices.

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