

# Transition in Domestic Energy Consumption in India and its Drivers at Grass Root level: A Logit Analysis

Jasleen Kaur and Dr. Sajad Ahmad Mir

MBA Student, Guru Kashi University, Talwandi Sabo, Bathinda

Assistant Professor, Guru Kashi University, Talwandi Sabo, Bathinda

**Abstract:** *Cooking on solid traditional fuel is the most common practice in the developing world and this is associated with several problems like harmful health impact on women, time spent on the collection of firewood, high dirt level, etc. Therefore, officials want to make its household sector to switch and use clean and modern fuels. The main aim of this paper is to examine whether fuel switching is taking place over years and what are the main factors related with rural energy transition to liquefied petroleum gas (LPG). This study first uses the NSSO reports and Census data related to the type of fuel used by households to know whether there is a shift in fuel type used over years and to have a deep insight into the main factors influencing this transition the study uses an extensive study of literature on fuel switching and after review of literature we observe some most important factors influencing the usage of fuel then uses logit model on primary data collected for four largest rural areas of India that empirically proves their impact of fuel usage. The results indicate that over years' fuel switching is taking place in rural India as per the data of NSSO reports shows and logit model shows that high household income of households is linked with more usage of modern fuel.*

**Keywords:** Fuel, Energy Consumption, Income, Gross Domestic Product, Rural Areas, etc

## I. INTRODUCTION

This is a well-known fact that since prehistoric times man has made lot of efforts to ease his life on the Earth, the outcome of which was the discovery of fire and secondly the use of fuels. Fuel is any substance which burns to provide heat or power and the energy which is released by the process of combustion is utilized for work. The release of energy is also accompanied by chemical or nuclear reactions sometimes depending on the nature of fuel undergoing combustion. Fuels can be regarded as concentrated store houses of energy which is released only on their burning. Their combustible nature owes to their organic origin as well as to their artificial formation. Wood, diesel, coal, domestic gas, petrol and biogas are some of the models of fuels. Fuels play a vital part in our daily life since they are used in households, transportation and various industries for providing vitality. This is also the most powerful engine of our socio economic development and lies at the base of every industrial economy. This energy coming from fuel is the most important component of all human activities, like heating, cooking, lighting, industrial output, mineral extraction and transportation. Without ensuring a minimum access to energy, no country can ever be able to develop beyond a subsistence level. Search for new sources is mainly backed by its importance in every aspects of life, not just at micro level, where it is useful for an individual while cooking, heating, getting warmth in winters, lightening of houses, travelling etc. But also on macro level fuel / energy sources play a pivotal role as they are base of every developmental process.

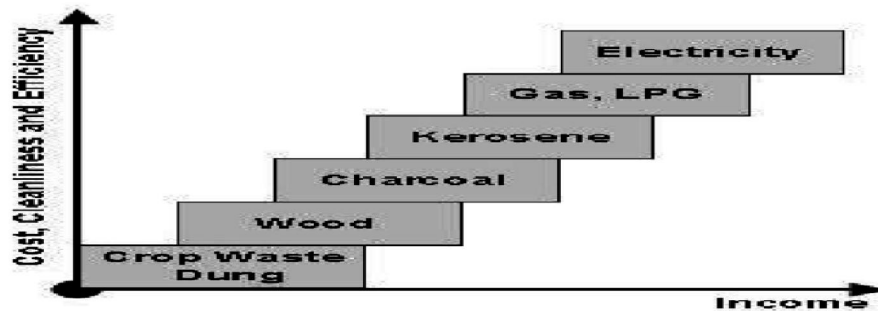
In every sector of an economy fuels are vital, whether it is an industrial sector where fuel like coal is used for heating boilers and electricity is used for running machinery (which itself is produced from coal, water and nuclear fuel in thermal, hydro and nuclear power plants). Even, the process of distribution of the final goods to distant places via trucks, railways and other vehicles is driven by fuels like petroleum, diesel, kerosene and electricity. In agricultural



sector petroleum, diesel and kerosene is used in running tractors, processing of the grains and transporting the final agricultural product to the consumers. In the services sector like trade, restaurants and banking etc. electricity (a byproduct of fuels) is used as well.

## II. ENERGY LADDER HYPOTHESES

Energy ladder hypotheses explain how energy choices are made by households residing in a particular area and how individuals move from one fuel to another (Reddy, 1996). This hypothesis tells and examines the choice of fuel made by households between different pairs of energy carriers, switching from one to another explains how income is the main determinant that makes households to ascend the energy ladder (Hetberg, 2003). Figure 1



Source: Research Gate

## III. RURAL ENERGY SCENARIO IN INDIA

India is land of more than 1.25 billion populations and is the second most populated country of the world; this shows that it is experiencing huge demand for energy sources. It is third largest economy of the world in terms of purchasing power and its GDP is growing around 7.6 percent, for maintaining such growth energy is very useful.

In India major sources of energy are coal, coke, firewood and chips, LPG, gohar gas, charcoal, kerosene, electricity and others. Of the total households, 52% of Indian family's consumption firewood as the chief source of food preparation (Census of India, 2001), while the percentage has decreased to 49 percent (Census of India, 2011).

Of all the fuels used by the total rural households, the use of firewood for cooking and other domestic purposes occupies the highest share which was around 64.1 percent, followed by crop residue contributing around 13.1 percent, cow dung contributing 12.8 percent, LPG with 5.7 percent, kerosene 1.6 percent, electricity 0.1 percent, any other 0.8 percent and 0.2 percent with no cooking arrangement (Census of India, 2001). Firewood repeated the same phenomenon after ten years with its contribution 62.5 percent in rural energy share, followed by crop residue 12.3 percent, LPG with 11.4 percent, cow dung 10.9 percent, kerosene 0.7 percent, electricity 0.1 percent, any other 0.6 percent and 0.2 percent with no cooking arrangement (Census of India 2011).

## IV. METHODOLOGY AND TECHNIQUE

For the study, the data has been collected by using National Sample Survey Organisation (2009 and 2011) regarding the type of energy used by the households in different states. Census of India report 2001 and 2011 has also been used. Section 2 includes the empirical study of four villages of Doda (J&K) i.e. Lalyaland Panjodh from Marh Block and Seri and Keri from Bhalwal block regarding the energy consumption pattern.

The study is mostly centered on primary data collected from the respondent households by means of discussion schedule for the present study. An interview schedule was initially established, anticipated and administered in the designated households in the sample villages in order to get appropriate data and information. The comprehensive interview schedule included facts regarding the family proportions, financial conditions of family, education level, fuel using



pattern, fuel mix constituents, housing characteristics comparable whether pacca or kaccha, electrified or not etc. Information had also been collected regarding willingness to switch to modern fuel in the areas.

The final sample size for the present study was 140 households 35 from each village. The next step after the collection of data started with the the analysis of the data to do the same, the data collected for the present study was tabulated and simple statistical tools like percentages were used.

**4.1. Results and discussion**

India is land of more than 1.25 billion populations and is the second most populated country of the world; this shows that it is experiencing huge demand for energy sources (Census of India, 2011). Major sources of energy are Coal, Coke, Firewood and Chips, LPG, Gobar Gas, Charcoal, Kerosene, Electricity and others. Of the total households, 52 percent of Indian households use firewood as the main source of cooking in 2001 (Census of India, 2001), while the percentage has decreased to 49 percent (Census of India, 2011). Of all the fuels used by the total rural households, the use of firewood for cooking and other domestic purposes occupies the highest share which was around 64.1 percent, followed by crop residue contributing around 13.1 percent, cow dung contributing 12.8 percent, LPG with 5.7percent, kerosene 1.6 percent, electricity 0.1 percent, any other 0.8 percent and 0.2 percent with no cooking arrangement (Census of India, 2001). Firewood repeated the same phenomenon after ten years with its contribution 62.5 percent in rural energy share, followed by crop residue 12.3percent, LPG with 11.4 percent, cow dung 10.9 percent, kerosene 0.7percent, electricity 0.1 percent, any other 0.6 percent and 0.2 percent with no cooking arrangement (Census of India 2011). This means that census of India 2011, in comparison to census of India 2001 shows that the share of fire wood, crop residue, cow dung, coal, kerosene and biogas has decreased while the contribution of LPG has increased. Figure 3

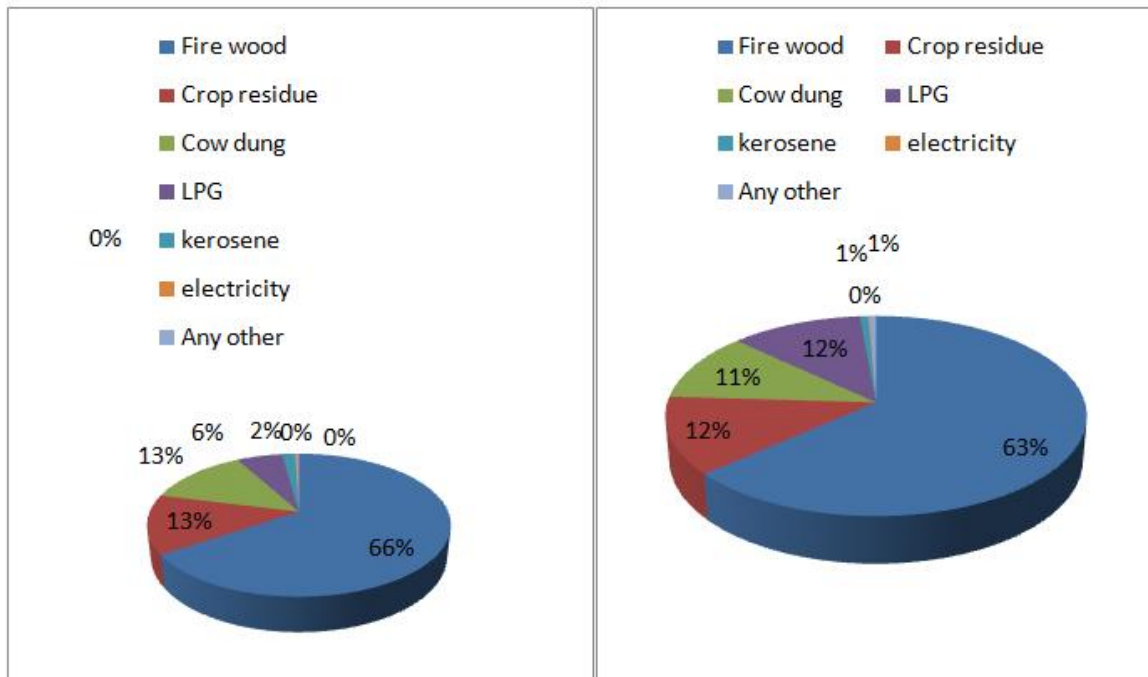


Figure1: Type of fuel used in rural areas during 2001 and 2011

Source: Authors own determination from Census of India, 2001 and 2011

According to NSSO report released for 2011-12, 67.3 percent use firewood and chip as the foremost basis of fuel for cooking, while LPG is used by 18 percent of rural households, followed by 9.6 percent of coal, 1.1 percent use coke and 4.9 percent use other sources like goober gas, charcoal, electricity and other sources. It means more than 2/3rd of the



rural households in India use firewood and chip as a source of cooking. The remaining 1.3 percent of households have no cooking arrangement. The percentage of households in rural areas who are dependent on firewood exceed 56 percent in all the states except Punjab and Haryana. Of all the states Chhattisgarh has highest number of people dependent on firewood and chip (93.3percent), followed by Rajasthan 89.3 percent and Orissa occupies the third place with 87 percent dependent on firewood. Cow dung has been used by 33.3 percent of the total rural households in UP, Punjab (30.3 percent), Haryana (24.4 percent.), and Bihar (20.8 percent). The use of LPG for cooking is highest in Tamil Nadu (37.2 percent.), Kerala (30.8 percent) and Punjab (30.5 percent) while its least use is in Chhattisgarh 1.5percent preceded by Jharkhand with (2.9 percent). Coke and coal as a prime source of energy is used in Jharkhand with14.3 percent and rural West Bengal with 6.5 percent while in Maharashtra its contribution is3.8percent. Figure 2

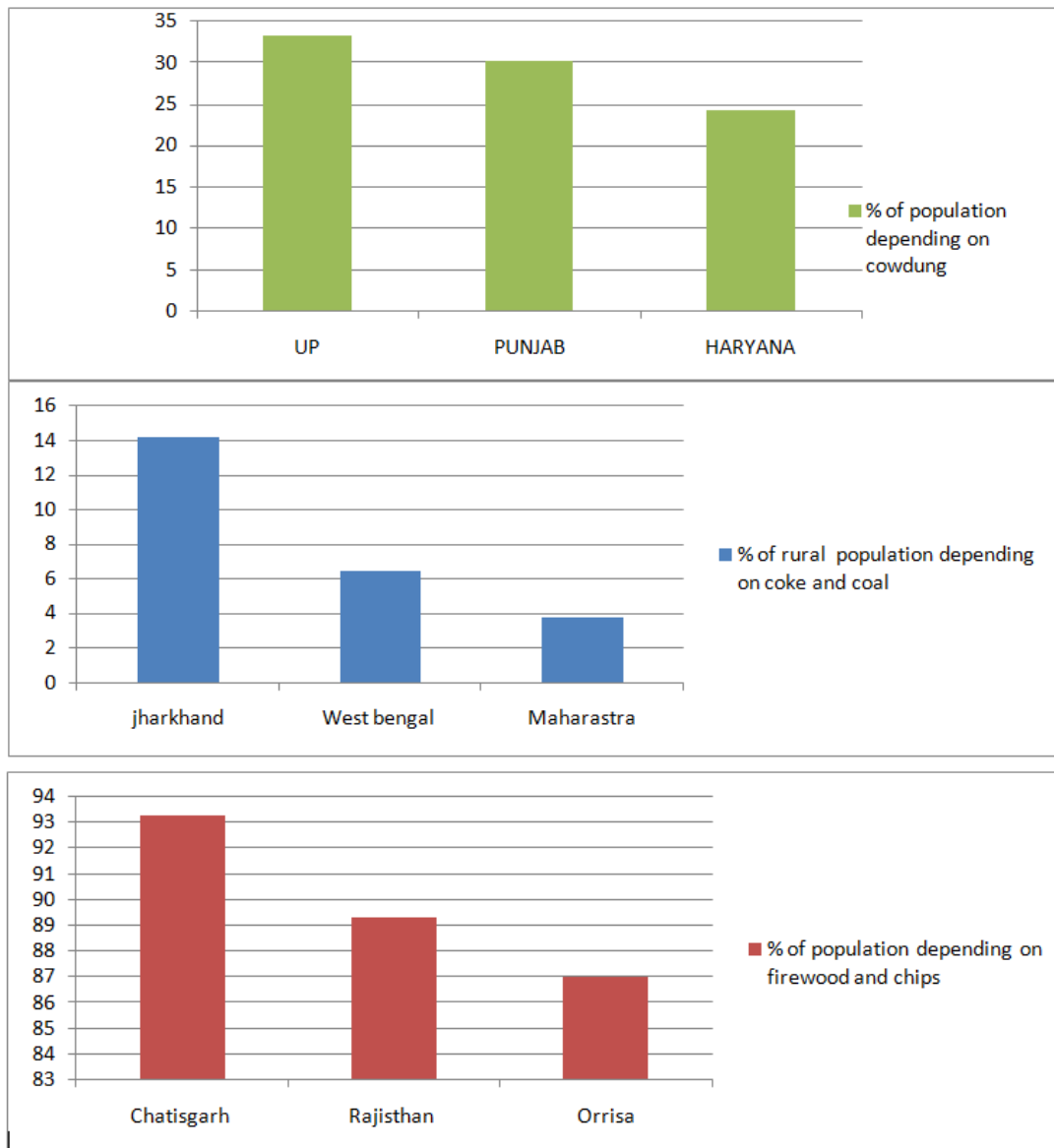
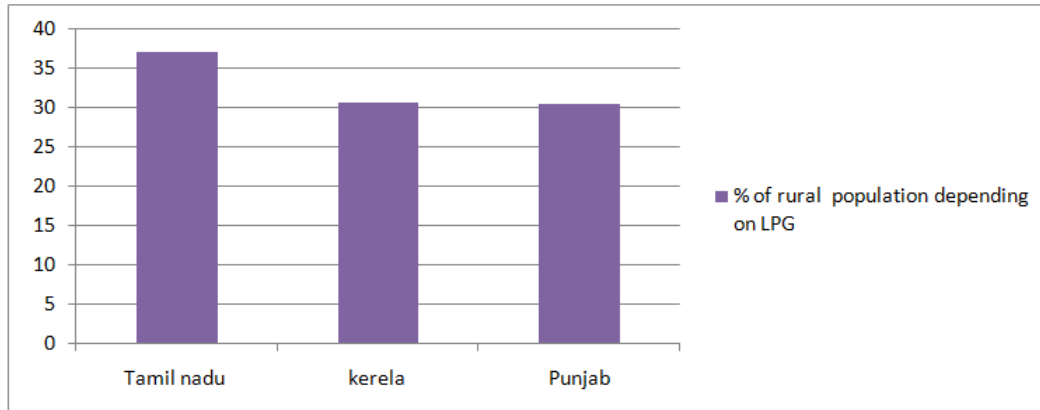


Figure2: Top three states with rural areas depending on firewood and chips, cow dung.





Sources: NSSO, 2011

The decadal trend however shows a drop of 8.2 percent since 1991-2000 as around 67.3 percent from 2011-2012 has been dependent on firewood and chip while the percentage of LPG use has increased from 5.4 percent to 15 percent (NSSO, 2011)

#### V. SOCIO –ECONOMIC PROFILE OF HOUSEHOLDS: EMPIRICAL STUDY

Household is the main energy consuming sector in any economy which is influenced by various factors like standard of living, education level of head, appliances being used, cook’s education, location of household, source of livelihood average temperature in the areas, household size and population residing at a place (Akpaluetal., 2011; Li and Lin, 2015). It is identified that type of fuel used by domiciliary related to the socio-economic status (Sadathet al., 2017; Yang 2018) and of these socio-economic include a number of factors like dependency ratio, income level of households, main source of occupation etc. Table 1 makes it clear that 77% of the sample area was dependent on 23% of working sample population which show high dependency ratio in the sample areas. Table 1. Most of the households either had small or nuclear family ranging from 4 to 6 members. The main occupation of households in the four sample villages i.e. 63%, 79%, 57% and 87% of the four villages were working as labourer in Lalyal and Panjodh from Marh Block and Seri and Keri from Bhalwal block

Earning and Dependent Status of sample households					
S. No.	Block	Village	Earning	Dependent	Total
1	Marh	Lalyal	37 (21.5)a	135 (78.5)a	172 (100)a
		Panjodh	38 (23.5)a	124 (76.5)a	162 (100)a
2	Bhalwal	Seri	40 (23.5)a	130 (76.5)a	170 (100)a
		Keri	40 (24.5)a	125 (75.5)a	165 (100)a
3	Total		155 (23.2)a	514 (76.8)a	669 (100)a

Source: Area assessment

Subscripta-shows the percentage of family type with respect to row total



### 5.1. Educational status of sample families

More the education level of members increases the level of awareness of households, More the education level of head is associated with more the level of awareness about the undesirable health impacts that are related with the utilization of traditional firewood (Farsi et al., 2007). Household with educated head and affluent families are most probable like to use modern and cleaner sources of energy like biogas, (Pandey and chaubal, 2010; Karimu, 2015). Literacy level of head of family having its influence on the choice of fuel shown in table 2 and table 3 It has been show that there is significant relation between the choice of clean fuel and literacy of head of household as the p value is <0.05 at 95 confidence level of interval.

### 5.2. Income as the factor influencing fuel usage

Income is the most significant factor influencing fuel choice. Among all the socio economic factors, income is the major determinant that influences the energy consumption pattern. Of the factors residential income is the most important. (Spalding 2005); Among all the socio economic factors, income is the main factor influencing the energy consumption pattern (Ravindra, 2011 Steve, 2014.). The income of the households of the sample areas had been divided into five categories 1 i.e up to 10000, 2- between 10000-20000, 3-between 20000-40000, 4-40000-60000, 5-above 60000. Majority of the sample households belonged to marginal to medium income group. Table 2 It has been show that there is significant relation between the choice of clean fuel and Income of household as the p value is <0.05 at 95 confidence level of interval. Table 2 also makes it clear that those household who were having low income were mainly dependent on traditional fuel while those households who were having high income were dependent on modern fuel which is similar to the findings to Abakah (1990); Masera (2000); Rahut (2018).

Estimation of the Logit Model

For valuation purpose, we write equation (6) as follows:

$$Li = \ln\left(\frac{Pi}{1 - Pi}\right) = \beta_0 + \beta_1 Yi + \beta_2 APL/BPL + \beta_3 Lil/Illilh + ui$$

$$Li = \ln\left(\frac{Pi}{1 - Pi}\right) = \beta_0 + \beta_1 Y_{1i} + \beta_2 APL/BPL + \beta_3 Lil/Illilh_{2i} + u_i$$

$$Zi = \beta_0 + \beta_1 Y_{1i} + \beta_2 APL/BPL + \beta_3 Lil/Illilh_{2i} + u_i$$

Logit results

Estimation of results

logit Clean/Dirty Y Lil/illi h APL\_BPL

Logistic regression

Number of obs = 140

LR chi2(2) = 96

Prob> chi2 = 0.0000

Log likelihood = -48.089854

Pseudo R2 = 0.5008

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
Lpg/firewood						
Y	.9689838	.3645507	2.66	0.008	.2544775	1.68349
Lil/illi h	2.727548	.9628201	2.83	0.005	.8404554	4.614641
APL/BPL	3.463494	.610432	5.67	0.000	2.267069	4.659918
_cons	-5.337493	1.138726	-4.69	0.000	-7.569354	-3.105631

Note: 0 failures and 1 success completely determined.



**5.2.1. Estimated Results and Discussion**

The assessed outcomes of the Effect of Income, Apl or BPL ration card and Head literate or illiterate are given in table 2. Results demonstrate that sign of most of the assessed coefficients are as expected, mainly for the entire sample. A brief description is given below for each explanatory variable.

The result shows that there is positive relationship between level of income and usage of clean fuel and it is significant at 5% degree of significance. One unit change in income brings 0.96 percent change in favor of clean fuel. It is proved that higher the level of income higher will be the usage of clean fuel

The result also shows that there is positive relationship between literacy of head and usage of clean fuel and it is significant at 5% degree of significance. One unit change in literacy of head brings 2.7 percent change in favor of clean fuel.

The result also shows that there is positive relationship between having Apl ration card on energy and usage of clean fuel and it is significant at 5% degree of significance. One unit change in expenditure on income brings 2.1 percent change in favor of clean fuel. It is proved that having APL ration card increases the probability of usage of clean fuel.

**C (Constant):**

**Income:**

It is statistically significant as the p-value is 0.008. As the income increases clean energy usage also increases.

**Literate head**

It is statistically significant as the p-value is 0.005. As the head of family is literate there increases clean fuel also increases.

**APL/BPL**

It is statistically significant as the p-value is 0.005. As the head of family is literate there increases clean fuel also increases.

Type of FUEL	Table 3: Highest education level of women in households					Total	Chi-square tests	
	Illiterate	Primary	Middle	Hr. Secondary	Graduate and above		Pearson p value	chi-square
Traditional Biomass	57	20	-	-	-	77	78.2920	<0.001
LPG	9	12	14	20	8	63		
Total	66	32	14	20	8	140		

**VI. KIND OF KITCHENS AND ITS CHARACTERISTICS**

Willingness to switch is not the answer but to make the grass root level switch actually need government to come forward as there is no policy meeting the needs of local rural households which could provide them free refilling along with improved cook stoves. Kind of kitchen and its characteristics is the main factor that determine the exposure to air pollution (Edwards et al., 2016). It was observed that most of surveyed rural households near the urban areas had modern kitchens but two villages i.e. Panjodhand Kerihad traditional kitchens which show the proneness of the households to get exposed to air pollution in the area.

Table.4. type of houses and use of traditional or modern fuel (%)

Type of house	Traditional chulah (%age)	Modern(%age)
Pacca	30	70
Semi pacca	10	25
kaccha	60	5
	100	100

Source: Calculated from field survey



Being dependent on traditional chulah there is need of such programme which can meet out this need to make them modern kitchen facility to be available as the households with modern kitchen facilities mostly prefer to cook on modern fuel. Recently govt. has launched PMUY which promises the modern kitchen facilities to those who cannot afford it i.e. the households with BPL ration cards Table 5

**VII. FACTOR GIVEN IMPORTANCE WHILE CHOOSING FUEL**

While choosing a fuel so many factors are taken into consideration like price level; low smoke level impact on the health, effect on environment etc. From the sample surveyed most of the households give 1st rank to price level which showed that most common characteristic of rural household while choosing a fuel is that these look into the price level followed by convenience to use fuel for domestic purpose.

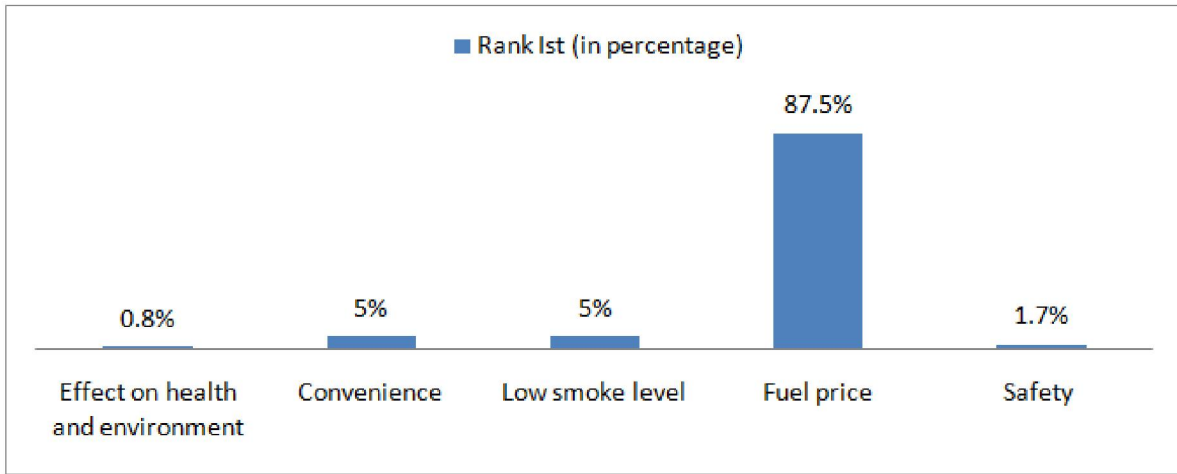


Figure1: Importance Given to the Factor while Choosing Fuel

Source: Fuel preference in four villages

Level of Fuel Switching and Willingness to Switch over among Respondent Households.

The households generally want to use clean and highly efficient fuel instead of traditional fuel because of its low quality (Ahmad et al., 2015). Maximum of the households in the four villages were willing to switch from the presently used source of energy for domestic purposes to LPG (81.6 percent of the total surveyed households while 11.7 percent did not want to switch from the fuel used by them as they were so poor that they first want to fulfill their basic needs.

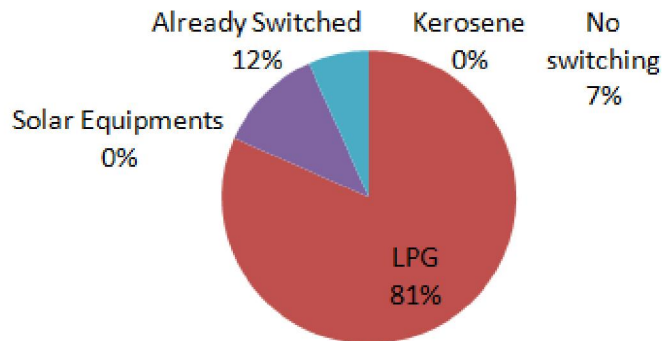


Figure 2 Willingness to switch

Willingness to switch is not the answer but to make the grassroot level switch actually need government to come forward as there is no policy meeting the needs of local to have improved cookstoves. Kind of kitchen and its characteristics is the main factor that determine the exposure to air pollution (Edwards et al., 2016; Sadath et al., 2017;



Ravindra, et al., 2019). It was observed that most of surveyed rural households near the urban areas had modern kitchens but two villages i.e. Panjodh and Keri had traditional kitchens which show the proneness of the households to get exposed to air contamination in the zone.

### VIII. CONCLUSION

From the study it can be concluded that in India still a large section of rural population is dependent on traditional cooking fuels and there many factors that are acting as a hurdle in switching to clean household energy like low income level, less education, high price of efficient fuel. So for making households to switch to modern fuel there is need to focus on social, cultural, and behavioral factors so that these may shift their reliance to modern fuel. There are a number of factors like income of households, occupation of head, kind of ration card, highest level of education of women in family, the taste of the meal, and the age of the cook that influence the household's choice of fuel and of them if we focus on increase in income, and educating women in the family there can be significant change in the energy consumption at grass root level. No doubt PMUY has been making a lot to shift to modern LPG but there is need to bring free refill provision in the scheme so that poor who prefer to use firewood which is available free of cost can think of shifting to modern fuel completely.

### REFERENCES

- [1]. Abakah, E. M. (1990). Real incomes and the consumption of woodfuels in Ghana: an analysis of recent trends. *Energy economics*, 12(3), 227-231.
- [2]. Akpalu, W., Dasmani, I., & Aglobitse, P. B. (2011). Demand for cooking fuels in a developing country: To what extent do taste and preferences matter? *Energy Policy*, 39(10), 6525-6531.
- [3]. Ahmad, S., & de Oliveira, J. A. P. (2015). Fuel switching in slum and non-slum households in urban India. *Journal of Cleaner Production*, 94, 130-136.
- [4]. Beltberg, R. (2005). Factors determining household fuel choice in Guatemala. *Environment and development economics*, 10(3), 337-361.
- [5]. Government of India (2011), *Energy Sources of Indian Households for cooking and lighting (NSSO 68th Round)*, Ministry of Statistics and Programme Implementation, New Delhi.
- [6]. Government of India (2001), *Census of India, 2011*, Ministry of Home Affairs, New Delhi.
- [7]. Government of India (2015), *Energy Sources of Indian Households for cooking and lighting (NSSO 71st Round)*, Ministry of Statistics and Programme Implementation, New Delhi.
- [8]. Mir SA (2017) *The Impact of Tourism Industry on Gross Domestic Product and Balance of Payments in India*. *Int J Econ ManagSci* 7: 498. doi: 10.4172/2162-6359.1000498
- [9]. Malla, S. (2013). Household energy consumption patterns and its environmental implications: Assessment of energy access and poverty in Nepal. *Energy policy*, 61, 990-1002
- [10]. Ravindra, K., Singh, T., & Mor, S. (2019). Emissions of air pollutants from primary crop residue burning in India and their mitigation strategies for cleaner emissions. *Journal of cleaner production*, 208, 261-273.
- [11]. Surab H. B., Mottaleb, K. A., Ali, A., & Aryal, J. (2018). The use and determinants of solar energy by Sub-Saharan African households. *International Journal of Sustainable Energy*, 37(8), 718-735

