

Das, Satyasiba; Pal, Suchitra

## Article

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## Kontakt/Contact

ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics  
Düsternbrooker Weg 120  
24105 Kiel (Germany)  
E-Mail: [rights\[at\]zbw.eu](mailto:rights[at]zbw.eu)  
<https://www.zbw.eu/>

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## Why not Liquefied Petroleum Gas? 4A Matrix of Energy Choice among Urban Below Poverty Line Households in India

Satyasiba Das<sup>1</sup>, Suchitra Pal<sup>2\*</sup>

<sup>1</sup>Indian Institute of Management, Raipur, Chhattisgarh, India, <sup>2</sup>Xavier School of Human Resource Management, Xavier University, Bhubaneswar, Odisha, India. \*Email: [suchitra@xub.edu.in](mailto:suchitra@xub.edu.in)

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### ABSTRACT

Liquefied petroleum gas (LPG) is one of the cleanest sources of fuel for urban below poverty line (BPL) households and households of urban BPL group are shifting from traditional cooking fuels to cleaner energy use. However, providing cleaner sources of cooking fuel to its urban BPL households has become one of the biggest challenges for developing countries. This paper reported on a recent survey on the household energy consumption pattern of urban (BPL) families living in the slums of Bhubaneswar, Odisha, India. The present study developed a 4A's matrix (Affordability, Availability, Awareness, and Attitude) to evaluate the different reasons behind acceptance and non-acceptance of LPG among the respondents. The results indicate that the 4 A's do not function in silos; rather they create a cumulative effect by working alongside of each other.

**Keywords:** Liquefied Petroleum Gas, Below Poverty Line, Energy Consumption

**JEL Classifications:** P28, I38, R22

### 1. INTRODUCTION

Household energy use is a major component of GHG emission in many developing countries as there is a preference for using solid fuel for cooking in the households of developing countries (Bonjour et al., 2013). Almost 80% of the total energy consumed in India is to meet the energy requirements for cooking NSSO (2001). Nearly half of the country still cooks with firewood and largely depend on traditional biomass fuels, charcoal, fuelwood, agricultural residues and animal dung (NSSO, 2001, Population Information Bureau, 2012, Johansson and Goldemberg, 2002), out of that three-fourths of India's populations uses firewood as their main fuel for cooking (NSS, 2010). However, till date, household, energy use got little attention, even though households are the main contributors to pollution, which is energy based and affects both the climate and human health. Choice model of energy use suggested that households often use multiple energy sources instead of a single one (ESMAP, 2001, Masera et al., 2000).

By 2030, the domestic energy sector is likely to see growth, at a faster rate in the demand for modern fuels like electricity and liquefied petroleum gas (LPG) (Bhattacharyya, 2015).

Most of the rural and urban population in India still depend on traditional fuel due to the high price and limited availability of clean fuels Jain (2010). Pachauri (2004a) observed that both in an urban and in a rural set up the role of household income and location contributes to the major energy consumption pattern. Bhatia (1998) reported that the poor households pay more than the higher income households, and most of the time the energy poor are also income poor (Khandker et al., 2012). Thus, energy plays an important role in both the development of society and poverty alleviation (Pachauri and Spreng, 2004). According to the Ministry of Petroleum and Natural Gas India, there are a total of 17.78 crores domestic LPG connections in the country making it 715 connections for every 1000 households. Per capita data on energy availability or energy consumption in India, does not amplify the household fuel choices because of changing

demographic conditions and specific policies targeting the household energy sector till Census 2011. India currently plans to introduce different subsidy systems and different financial schemes for below poverty line citizens, to boost the adoption and use of LPG in the rural population (Lucon et al., 2004; Smith and Sagar, 2014; Tripathi et al., 2015). However, it is not clear, from the aforementioned report, about the number of households in urban, rural, and (the below poverty line [BPL] group) in urban areas using LPG.

Previous researches mainly focused on energy consumption patterns of rural Indian households. Of India's total population, 27.1-28.3% of rural population and 23.6-25.7% of the urban population has been reported as living below the poverty line (Indian Statistic). According to the World Bank (2009b) report for the local governments, it is a major challenge in delivering modern energy service to rapidly growing low income and urban settlement areas. Our paper reports on the urban BPL household's energy consumption pattern in Bhubaneswar city of Odisha, India. Therefore, the purpose of this paper is to systematically find out the reason behind the acceptance and non-acceptance of LPG, as a fuel source, among the selected BPL card holders in Bhubaneswar city. We have arrived at four pillars from an economic, social, and psychological perspective which will ultimately help in determining the energy choice of a certain household. The four salient factors which determine a household's ultimate energy choice decision are Affordability, Availability, Attitude, and Awareness. We call it the "4A Matrix of Energy choice" and we will find out how far these matrices contribute to the use of LPG among urban BPL households (Figure 1).

### 1.1. Background of Bhubaneswar City in the State of Odisha

Bhubaneswar, one of the first planned cities in India and the state capital of Odisha, has become prominent owing to its economic and religious importance. Bhubaneswar Municipal Corporation (BMC) covers an area of 135 km<sup>2</sup> and provides service to 8.41 lakh people. BMC area includes 377 slums where 3.09 lakh people live in 60,126 households. 37% of the BMC population live in slums. Expansion of the city, and a large slum population is becoming a serious issue for cities like Bhubaneswar, over the last decade. Growing urbanization and employment opportunities have attracted a vast majority of people to move from their villages to earn a basic livelihood.

In Bihar and Odisha, the spread of LPG lags far behind the rest of the country, with <12% of households in both states using LPG. The difference among the states in energy use may be due to the market variation and significant policy autonomy of Indian states (Jenkins, 2004; Sinha, 2005). The key question is thus, what kind of intervention is required to facilitate the use of LPG among the lower end of the consumer pyramid. At the same time, government initiatives, have favoured the economically sound, because of the inequalities in fuel and equipment available in the different income groups (Alam et al., 1998).

## 2. METHODOLOGY

A month-long LPG outreach survey was undertaken for hundred percentage LPG usage among BPL households, through document

analysis and a self-reported questionnaire was filled out by the interviewers.

### 2.1. Research Sample

The sample consists of 3,065 respondents from three identified slums of Bhubaneswar city, (i.e., SaliaSahi, Ghatika, and Bharatpur), Odisha.

### 2.2. Research Questions

The present study is divided into five parts. A pilot study was conducted to improve the reliability and validity of the questionnaire used for this present study. Part 1 of the survey consists of general information regarding the respondents which includes demographics (for e.g., age, gender, monthly income of the households). The personal information is about the main source of income, monthly household income, economic status, whether they have any photo identity card, a bank account in their name, mobile number, type of house they live in etc. Part 2 of the survey is about the acceptance/awareness of LPG among the respondents. For e.g., average time spent in cooking, for how long they have been using LPG, size of the LPG cylinder used (for e.g., 5 kg or 14.2 kg), the source from where they buy the cylinder (for e.g., official source or grey market) etc. Part 3 (A) of the survey is all about the non-acceptance of the LPG connection which covers, "if not using LPG at present, then, for what reasons?" For e.g., is there any personal problem in getting an LPG connection or the problem is from the distributors/suppliers of LPG in your locality. Under personal problems, we have asked, whether financial constraints are the reason for not having an LPG connection? Whether they have ever tried to get an LPG connection? Whether firewood is easily available in their locality! Whether they have a valid, official documentation required for getting an LPG connection? On the distributor/supplier side we have asked about the cooperative attitude of the nearest distributors, the availability of the nearest distributors etc. Part 3 (B) also covers non-acceptance due to availability/non-availability of identity proof or whether the proof was not for the present address, problems faced by the participants while transferring the LPG connection from permanent to their present address etc. Part 4 covers measuring the positive attitude of the participants interested in taking LPG connections in the future (filled up by the participants who do not have LPG connections and those buying from the grey market at present). Part 5 is all about those not having an LPG connection but possessing the potential to afford LPG in the future.

## 3. RESULTS AND DISCUSSION

Part 1 of the survey covers the general information about the participants. Out of 3036 participants, 1804 were male (59.4% of the respondents) and 1174 were females (38.7% of the total respondents). There were 11 missing cases. The average age of the participants was 38. Among the respondents 563(18.5%) were from Schedule Castes, 342 (11.26%) were from Scheduled Tribes, 860 (28.32%) were Other Backward Classes, 1015 (33.43%) were from general categories and 206 (6.78%) were from minority groups. Most of the respondents were from general categories and out of that 15.6% live in Pucca houses, 72.4 % live in semi Pucca and the other 3% live in kutchha houses.

More than 50% of the respondents did not have any type of identity proof which would enable them to get social benefits as an Indian citizen. There were more ration card holders than BPL card holders. To understand the economic status in a better way we have asked the respondents about their monthly household income. 10.7% of the participants earn >2000 rupees/month (close to 30 dollars/months), 54.3% of the respondents earn >5000 rupees/month and <10,000 rupees/month. 29% of the respondents earn >10,000 rupees/month. When it came to having a bank account in their name or in the name of one of their family members, 2458 (81%) of the respondents replied in the affirmative and 439 (14.5%) of the respondents reported that they did not have any bank account. The remaining 90 (3%) of the respondents were not ready to disclose information about their bank account. (Note: The numbers of participants mentioned above were those who were able to produce an identity proof at the time of interview).

Part 2 of the survey focused on the awareness level of the participants about LPG connections and acceptance level of the participants about the use of LPG. Respondents were asked about the approximate time they spend in cooking per day. 106 (3.5%) of the total sample spent an hour cooking every day, followed by 1229 (40.5%) who spent 2 h/day, in cooking, and a majority of the respondents 1349 (44.4%) spent 3 h/day, in cooking.

From Table 1, it is clear that 38% of the participants were using LPG as one of the sources of cooking fuel. We also asked the respondents when they have started using LPG as one of the sources of fuel, for cooking, 41% of respondents replied that they are had been using it for the last 5 years. 38% of the total participants in number (1169 participants) were asked whether they had LPG connection from the government or private sources and we found that 626 respondents had connections from government sources and 183 respondents had LPG connections from private sources (grey market).

From Table 2 it is clear that out of 1169 LPG users 405 (35%) of them use it for 1.5 h/day. 307 out of 1169 (26.26%) use it for 3 h/day. Another 25% of them were not sure about the amount of time spent, followed by 4% who used it for <1 h and <3% used it for an hour each day. Details regarding the size of the cylinder being used, were that, out of 1150 LPG users 650 of them had 14.2 kg cylinders and 192 respondents were using 5 kg cylinders. 582 respondents had a single cylinder and 258 respondents had double connections. 859 respondents gave information about the source from where they bought the cylinder and refill the empty cylinder. 228 respondents out of 859 (which was 27% of the LPG users in the present survey) were buying from the grey market paying an average of Rs. 580 per cylinder/refill.

Part 3 (A and B of the survey covers the non - acceptance of LPG/availability of documents for LPG connections).

From Table 3 some of the reasons identified for not having an LPG connection becomes clear. Out of ten reasons mentioned above, lack of income (1311 agree and 526 disagree), never made an attempt to get an official connection (1016 agree and 556 disagree), followed by LPG connections not available freely (548

**Table 1: Primary source of fuel used for cooking**

Source of fuel	Participants (%)
Firewood	34
Electric heater	02
Kerosene	18
LPG	38
Coal briquette	0.3
Induction cooker (electric stove)	0.1

LPG: Liquefied petroleum gas

**Table 2: Approximate time spent on cooking per day with LPG (n=1169)**

Hours of cooking (h)	No of participants
0.5	47
1	28
1.5	405
2	13
3	307
Not sure about it	361

LPG: Liquefied petroleum gas

agree and 991 disagree) were the major reasons for not having an LPG connection. At the same time, documents i possess, were not accepted by the distributors (300 agree and 1394 disagree), valid documents (147 agree and 1375 disagree), distributors are far away (354 agree and 1183 disagree), lack of space (224 agree and 1279 disagree), and followed by in case of fear of safety, leakages and explosions (99 agree and 1383 disagree), were the major reasons behind the non-acceptance of LPG connections.

Out of 1839 non-acceptance 16% (236) of the participants have valid BPL cards. 137 households have a BPL card for their current address and 99 of them have it with their permanent address (the village to which the respondents originally belong).

From the Table 4, it is clear that close to 45% of the household were aware of the LPG connection schemes, 35% of the households are aware of the total cost of the new LPG connections, 42% of the households are aware of the refill cost and subsidy given for each cylinder.

Part 4 of the survey studied the positive attitude of the households not having the LPG connections, which is reported in Table 5. It reports about the positive attitude of the household to get an LPG connection in the future (The data include the non-users of LPG and the buyers from Grey market). Close to 98% (2147/2187) of the non-users have a positive attitude towards taking an LPG connection in the future.

Part 5 of the survey measure the affordability of the households not having LPG connections but can afford in near future and reported in Table 6.

However, when respondents were asked about the affordability of LPG, 97% of the household not having official LPG connections (n = 2011) confirmed that they could afford the connection within the next 3 months. 60% of the (n = 2011) were spending 500-1000 rupees/months buying other sources of fuel. The survey showed that 51% of the respondents could afford the additional



**Table 3: Reasons behind the non-acceptance of LPG in households (n=1839)**

Reasons behind non-acceptance of LPG	Respondents	Yes (%)	No (%)
Never tried to get an official connection	1572	1016 (65)	556 (35)
LPG connections not available freely	1539	548 (35)	991 (65)
Distributors are far away	1537	354 (23)	1183 (77)
Distributor is Non-cooperative	1525	205 (13)	1319 (87)
Address/ID proof problem	1547	205 (13)	1342 (87)
I have not been accepted by the distributor	1522	147 (9)	1375 (91)
I do not have valid documents	1694	300 (13)	1394 (83)
Lack of income	1839	1311 (72)	526 (28)
Lack of space in the home	1505	224 (15)	1279 (85)
Fear of safety like leakages and explosion	1483	99 (7)	1383 (94)

LPG: Liquefied petroleum gas

expenses of availing an LPG connection.

### 3.1. Discussion about the Major Findings of the Survey (Linking the 4A Matrix)

The first factor that is of great importance in the energy choice matrix is that of “availability.” To begin with, we must understand the dimension of availability of LPG from a rural and urban perspective. The principal reason for underdeveloped and developing countries using firewood, rampantly, as a means of cooking fuel is the extensive availability of biomass and firewood. The rationale is simple in such situations; there is no motivation to spend on cooking fuel when it is available for free. The study conducted by Bisu et al. (2016) on a Nigerian sample reported that a policy encouraging availability of LPG will force citizens to use cleaner cooking fuel. However, in the cities (urban areas) biomass isn’t available freely hence there is a higher possibility of a household using LPG or other clean cooking sources. Availability dimension is also linked to the opportunity cost perspective Heltberg (2003a). In households where there are a higher proportion of females, who do not undertake jobs outside the household, there is ample amount of time available to search for and prepare biomass as cooking fuel. Even though these means of cooking might take up a higher amount of cooking time, there is ample time available which counterfeits any reason to take up LPG or any other clean cooking fuel.

In the present study, we have measured availability dimension by asking the respondents whether LPG connections were not freely available! 35% of the respondents responded with a “yes.” For the lower income bracket, the meaning of freely available is that they can procure it from the grey market by bypassing the official channel. The reason they use the grey market for procurement is that they do not have the official requirements such as an identity card, which makes it difficult for them to utilise the official channel for procurement. For procurement of LPG, participants preferred the grey market over the official route where the dealer had either informed them that official connections had been stopped for the time-being or that they did not have valid documents for a connection. Additionally, the initial cost of the deposit for an LPG connection was too high for the participants to afford and, the requirement of having to purchase a stove from the distributor, which is available in the market at a cheaper price, was an issue. Previous studies on energy choices also supported our findings and concluded that the lack of purchasing power in developing economies, are a major barrier to use clean energy (Heltberg et al.,

**Table 4: Awareness of LPG connections schemes (n=3001)**

Awareness	Yes	No
Aware about the present cost of taking LPG connections	1267	1501
Have anybody told you about the LPG connection	1347	1179
Total cost for getting one connection	1043	1425
Refill cost of the cylinder	1239	1359
Awareness about the subsidy	1184	1238
Subsidy given for each cylinder	1250	1179

LPG: Liquefied petroleum gas

**Table 5: Positive attitude of the households to go for LPG connections in future (n=2187)**

Attitude	Yes	No
Do you have any interest to use LPG cylinder?	2147	37
If an official gas connection is provided, are you ready to afford and use LPG for cooking in future?	2136	40

LPG: Liquefied petroleum gas

**Table 6: Affordability of studied households (n=2011)**

Money can spend on the security deposit		Money can spend on refilling the cylinders/month	
INR 500-1000	36%	INR 300	20%
INR 1000-2000	25%	INR 500	40%
INR 1500-3000	27%	INR 1000	22%
>INR 3000	2%	INR 1500	18%

INR: Indian rupee

2000). Similarly, respondents favoured the convenience the grey market, which allowed them to purchase a refill, whenever they required it. The grey market also allowed them to purchase and refill gas according to the quantity they could afford or desired. One respondent reported that from the grey market he could purchase a refill (In a 5 kg cylinder I can refill 2 kg Gas) according to his needs. For making this significant shift from the grey market to official channels, policy interventions will have to be directed to these pain points, the major ones being issues with the identity card, bank account, and address proof. There will have to be initial groundwork which needs to check these boxes and once these issues are addressed and a redressed mechanism attached as a tertiary to LPG procurement, there will be a significant improvement in LPG usage amongst the lower income bracket.

The second factor in the energy choice matrix is “affordability.” From extensive literature review and quantitative analysis, we can

**Figure 1:** 4A matrix of energy choice

AFFORDABILITY	AVAILABILITY
ATTITUDE	AWARENESS

safely conclude that affordability is another principle component in determining a household's energy choice. From the survey we can decipher that middle and low-income groups have an inclination towards using LPG and the convenience of using LPG is a striking factor for them notwithstanding the fact that they have the capability to afford LPG as a fuel source for cooking. The higher income bracket will continue to use LPG, irrespective of the subsidy or policy changes since it is more likely a way of life for them. The lower income groups are eligible for kerosene subsidies but the rapid shift towards using LPG has reduced the burden of kerosene subsidies on the Government. This shift is mainly due to the increasing disposable income in the middle and high-income brackets. The initial outgo on the purchase of a cylinder and stove is evidently the foremost barrier to the penetration/use of modern cooking fuels. The same result was also found in the study conducted on Indian data by (Nayak et al., 2015). Across this range of perspectives, however, the dominant underlying position has been that price differentials serve not to influence consumer preferences or active decision making but to reduce the range of affordable choices, preventing the poor from using "more "decent" sources of fuel supply like LPG, biogas, kerosene, etc." (Akabiah, 1990, p. 231).

For the Government's policy initiatives to be successful, it will have to ensure a way to provide for the high initial cost incurred to secure a connection. Microfinance agencies could be a big help in this direction. Other developing countries such as Bangladesh have started to rely heavily on the microfinance structure for social upliftment. India could also use microfinance as a means to reach a middle ground in this scenario. Also, instead of charging an upfront setup cost which is difficult to pay at one go, the price could be evenly distributed across various months so that the burden is not borne all at once. Policy interventions need to be in the direction wherein they make LPG more affordable to use, but this does not mean that subsidies are the only way out. Previous studies reported that giving a subsidy is also not helpful to attract using LPG because there could be financial arrangements which are made so that a middle ground is reached, and solutions of this type would be more sustainable than mere subsidies, discounts or price reductions. This will help in looking at the whole scenario from a long-term perspective. On enquiring why LPG users prefer the grey market, the responses are as under: "I have the facility, in the grey market to pay for a quantity convenient for me"; (In a 5 kg cylinder I can refill 2 kg gas). For the non-acceptance category, 10% of the household's average income is Rs. 3000/month. 47% of the households earn an average of 5000 rupees and beyond Rs. 5000/-there were 43% of the households. From the average income, it is clear that they can afford LPG as a cooking fuel up to some extent.

The next factor in the energy choice matrix is "awareness" about the cooking fuel. The key understanding here is that the target population in the present research are BPL households, who have attained a bare minimum education and the basic need of life is not satisfied. Close to a billion people are estimated to live in slums

and shanty homes in developing countries, to spread awareness and deliver modern energy service is a big challenge (World Bank, 2009b). In order to enhance the demand for cleaner fuels, there needs to be an increased awareness about the health, economic, social, and environmental benefits of clean fuels. The study by Ramirez et al. (2013) clearly stated that proper information about cleaner sources of cooking fuel available to households will help people to switch to LPG. Once, this awareness has been taken care of the government can continue to drive scale by focusing on fuels with impact and extending fuel supply chains and last mile distribution. Policy makers need to push for advocacy platforms and awareness creation. Consumers are expected to make informed decisions after they are made aware of the benefits of clean cooking fuel. Most of the respondents reside in semi-pucca or kuccha houses which do not have separate kitchen facilities and they feel that it is unsafe to use LPG inside the house with children around. Awareness and understanding around issues of this kind will help in boosting the use of cleaner fuel.

The last quadrant of the energy choice matrix is the "attitude" of the end consumer. Attitudes are defined as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favour or disfavour" (Eagly and Chaiken, 1993, p. 1). Behavioral attitude and preferences have a huge role to play in determining cooking practices and that in turn also has a role in governing the attitude the final consumer has towards using LPG. Once the consumer surpasses quadrants such as affordability, availability, awareness, the last mile is primarily to develop an attitude towards using LPG as a clean fuel and give up on other cheaper sources. There are cases in our survey responses wherein the households have the capability to afford LPG, they are aware of the procedures and practices, but from an attitudinal perspective, they do not want to embrace a new practice. Once the consumers have surpassed the other three quadrants this quadrant will be the most difficult to achieve because this needs to be intrinsically driven by the consumer rather than extrinsically driven by the government or any other external agent. First, as early as the 1980s, Black et al. (1985) recognized that various socioeconomic, attitudinal, and physical factors are associated with different energy-saving behaviors but till date, to our knowledge, not a single paper focused on the attitude as energy use behaviour. From the analysis of how much the respondents spent to buy fuel every month, 57% of the households have fuel expenses of 15% of their monthly income and 20% of fuel expenses for rest of the households. 83% (n = 868) of the households declare that they can spend up to Rs. 600/month for refills. As LPG will be a recurring expenditure 48% of the respondents are willing to have additional expenses and 57% said that they require monthly refilling. At the same time, 98% of non-users and grey market LPG users have a positive attitude to spending money to get an official LPG connection within the next 6 months.

## 4. CONCLUSION

According to the result of the present study, we can conclude that there are inherent correlations amongst this 4A Matrix of energy choice. There was a similar study focused on the sustainable uptake of LPG in rural India using 3A matrix of energy choice (Kumar

et al., 2016). The 4<sup>th</sup> component of our matrix, attitude, plays a major role in energy choice and is a special contribution of our present study which gives direction to further energy research. We found that energy consumption need is also a factor of many non-economical and non-technical factors, which is supported by previous studies on energy use (Lutzenhiser, 1993; Saatkamp et al., 2000; Abrahamse et al., 2005; Stern, 2007; Wilson and Dowlatabadi, 2007).

The present paper focused on BPL living in slums of urban surroundings of Bhubaneswar city. The 4A matrix can be studied from BPL consumers residing in highly populated slums of big Indian metro cities. The future research will help to generalize the 4A matrix and its pattern among different sample.

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