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SOCIOECONOMIC CONSEQUENCES AND ANALYSIS OF SUI GAS LOAD SHEDDING AT HOUSEHOLD LEVEL IN FAISALABAD

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ABSTRACT

Natural gas plays a vital role in the growth and development of every country globally, as all economic and human activities depend on it. Industrialization accompanied by economic development and improved standard of living has enhanced the demand for natural gas in many fields. The consumption of sui gas has spiked since the last decade in Pakistan. No addition has been made to improve the supply of sui gas, so a gap between the demand and supply of natural gas is widening in the country. The present natural gas load shedding resulted in massive losses to the economy and created anxiety for families at the household level. The present study was designed to identify the socioeconomic consequences and problems of sui gas shortfall in households. The results of the current study revealed that sui gas load shedding badly hampered household activities. Results indicated the average bills of sui gas more in winter than summer. Average electricity bills were more in summer than winter. As their income increased, they consumed more energy using vehicles, coal, generator, and geyser, which caused an increase in their average monthly expenditures. It was found that there was huge gas load shedding up to 20 hours in winter and in some areas people faced 24 hours sui gas load shedding, in order to overcome the situation households were used alternatives like a cylinder, oil stove, wood fire and people also preferred to purchase food from markets for their breakfast, lunch and dinner needs that increased their expenditures. These alternatives were caused to create health issues, unrest among the families and unemployment. To avoid these issues and for uninterrupted sui gas supply, households are willing to pay extra tariffs. The results of regression analysis were indicating that family size, income, heater and geyser had positive and significant impact on gas expenditures. There was positive and significant relationship between the willingness to pay of the households and income, alternatives cost, LSH, health and FD. In contrast, the result of binary logistic model showed that explanatory variables LSH, income, EOJ and GJT are positively and significantly influencing the use of alternatives expect CGST.

Keywords: Sui gas; Gas shortfall; Load shedding; Alternatives; Households; Willingness to pay.

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INTRODUCTION

Energy is the ability of system to do work or the capacity to change from of matter. Energy may be found in various things and it takes many forms; most of the energy we use on earth originates from the sun in addition natural gas, oil, coal, and biomass. Wind and hydropower, which are using to generate electricity, also drive their energy contents from the sun. Energy may move in the shape of electromagnetic waves like light, heat, gamma rays and radio, the human body is containing metabolic energy. If you rub your hands, you have converted metabolic energy into mechanical energy which makes your hands heat up, which mean you are converting mechanical energy into heat energy. Energy is flowing and changing forms constantly. Fire was a great discovery of civilization and wood was burned as fuel at the household level and for business in the late 1700th century. Later on, it was used for power generation and space heating. It was the dominant energy source due to easy availability, portability and could be consumed on demand.

Energy is to be considered as the lifeline of the very economical and most important instrument of economic growth and socio-economic development.

High consumption of energy is common among industrial countries. The people use oil, coal, and natural gas to power their machinery and gadgets, heat their houses, and fuel their vehicles (API, 2015). The total primary energy production and consumption globally is 537 and 524 Quadrillion British thermal unit (Btu), respectively (EIA, 2016). Providing inexpensive and uninterrupted energy is essential for reducing poverty, improving the standard of living and raising human welfare. Fossil fuels have also been key source of energy it has been fulfilled the human energy demand. Renewable energy sources are also very important for humans since starting of civilization. Biomass is used for heating, steam production and cooking. Hydropower and wind energy are used for transport and electricity production (Muneer & Asif, 2007). South Asia is vital for the world's energy market because 1.3 billion people live in it, and their energy demand is also increasing; as a result, the supply of energy is less than the actual demand; therefore, energy crisis is increasing day by day. An energy crisis may be defined as any great bottleneck (or price rise) in the supply of energy resources to an economy (Muhammad et al., 2013).

South Asia produced 19 Quadrillion Btu and consumed 28 Quadrillion Btu total primary energy, and the economy of Pakistan is struggling with unemployment, sluggish economic growth, high inflation rate, circular debt, costly energy sources and lack of transmission and distribution system. These are the major causes of energy crises in the country. Pakistan produced 1.809 Quadrillion Btu and consumed 2.664 Quadrillion Btu of total primary energy. The gap in South Asia is -9.219 Quadrillion Btu which is 48.5 percent of consumption and in Pakistan -0.855 Quadrillion Btu which is 47.26 percent of consumption (EIA, 2016). The energy that is used in Pakistan comes from two sources, i.e., renewable and nonrenewable. The commonly used renewable energy in the world is solar, hydro wind and bioenergy. The major sources of nonrenewable energy are fossil fuels, i.e., petrol and natural gas. Total supply of energy in Pakistan comes from various sources, the composition of energy shows that the share of natural gas is 48.20 percent, oil is 32.50 percent, hydroelectricity is 11 percent, coal is 6 percent, nuclear is 1.70 percent and LPG is 0.60 percent in total energy. These statistics indicate that natural gas and oil are the two largest contributors in the total energy supplies accounting for about 80 percent of energy demand. According to the sector-wise share of energy consumption in Pakistan, household's sectors consume 25.20 percent, industrial sector consumes 35.40 percent, agricultural sector consumes 1.80 percent, commercial sector consumes 4.10 percent, government sector consumes 2 percent, and transport sector consumes 31.50 percent. Data showed that there are three major consumers in Pakistan by sector, i.e., industrial, transport, and household sector, which consumed about 90 percent of total energy (EFP, 2016).

Total electricity generation capacity in Pakistan was 23011MW in 2013, installed capacity of hydro 6556MW, thermal power plants production in the public sector was 7110MW, and private sector produce 8353MW (EFP, 2016). The included generation capacity had never been fully utilized either because of lack funds or due to technical faults as there production units are operating beyond the operational life as a result Electricity Load shedding is an old phenomenon in the Pakistan. Pakistan was facing almost 10 hours electricity load shedding per day due to gap between supply and demand of electricity, to overcome the crisis Government of Pakistan adopted a new investment policy to attract the foreign investors in the energy sector. As a result of this policy new power plants were constructed in the country which was oil and gas based; these plants were less costly and easy to construct as compared to other high oil cost coupled with poor management and corrupt system. The electricity produced from oil is very expensive and led to huge circular debts that were also responsible for electric shortage in last few years. Reasons for these debts are power theft on large scale and elite's class as well as government doesn't pay electricity bills.

The electricity generated from natural gas is cheap but gas companies are unable to meet the increasing gas demand in the country. So the shortage of supply of natural gas to power plant fluster aggregated electricity load shedding in the country (Patel & Zhao, 2014). Natural gas is growing as key energy source worldwide. Pakistan had 26.9 (TCF) trillion cubic feet of verified natural gas assets and Pakistan considered to grow its gas fabrication to support growing consumption through Turkmenistan-Iran pipelines (Muhammad et al., 2013). Natural gas consumption by sector was general industry 23 percent, commercial 3.1 percent, cement 0.1 percent, transport (CNG) 9.2 percent, fertilizer (fuel) 3.3 percent and power 27.8 percent. Coal consumption by sector was cement 54.5 percent, power 1.4 percent, coke use 3.6 percent and brick kilns 40.5 percent (PEYB, 2013). Gas transmission and distribution network of Pakistan is one of the most developed in the region, the gap between demand and supply become widen due to an increase its share in the energy consumption as shown in figure 1 shortfall started from 1998-99 which continuously goes up (GOP, 2015).

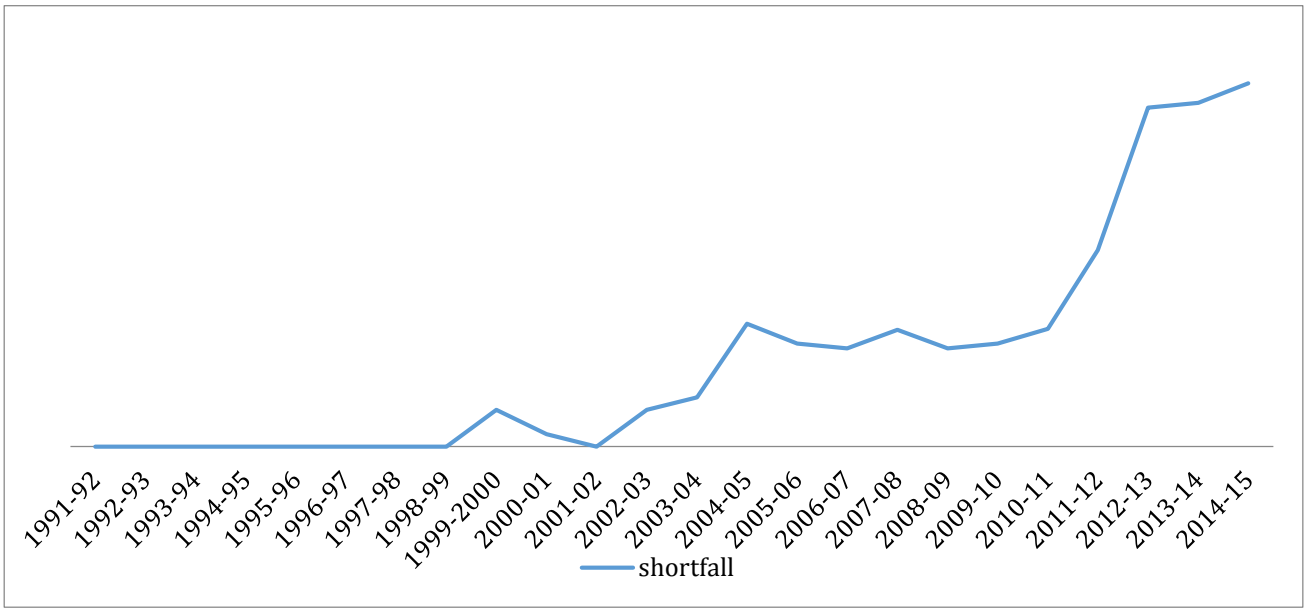

Figure 1. Natural gas shortfall.

Source: Economic Survey of Pakistan, 2015.

The gap demand and supply of natural gas started when gas is become cheaper substituted for oil and other reason of this gap was political will to provide new gas connection to consumers on account of annual development scheme. 72 KM gas transmission network laid by the (SNGPL and SSGCL) gas utility companies also 1040 KM and 758 KM distribution and services line and 59 village/town connected to gas network during July 2014 to Feb 2015. Total 206473 new gas connections provided including 206127, 249 and 97 domestic, commercial and industrial connections respectively in the country the gas shortage now faced by the consumer in summer also due to demand and supply gap and depletion of existing energy sources. Government of Pakistan tries to over-come the shortfall of natural gas through hold natural gas demand on current level, upsurge in original gas supply, import of LPG air mix, Pak-Iran gas pipeline, Pak-Turkmenistan gas trade and import of LNG. During winters, individuals of Pakistan are confronting the challenge of hurting and shocking gas load shedding. Sui Northern Gas pipeline Limited (SNGPL) has 4.7 million household, business, CNG and industrial customers. On an average, every year gas demand rises by 40 to 50 Million Meter Cubic Feet (MMCF) for every day during summer from 80 to 100 MMCF for every day during winters. At present, the SNGPL is confronting a general deficit of 1,400 million meter cubic feet for every day. The SNGPL unaccounted for gas shortage remained at around 10 percent with 3 percent to 4 percent of theft while rests 6 percent to 7 percent are the distribution losses. The figure 2 shows the province wise last five years average consumption and production of gas In Punjab, during last five years

there is huge gap between production and consumption of natural gas i.e. 5 percent to 46 percent the exports of the textile industry have fell down to 4 percent and textile production to 25 percent in the province (GOP, 2015).

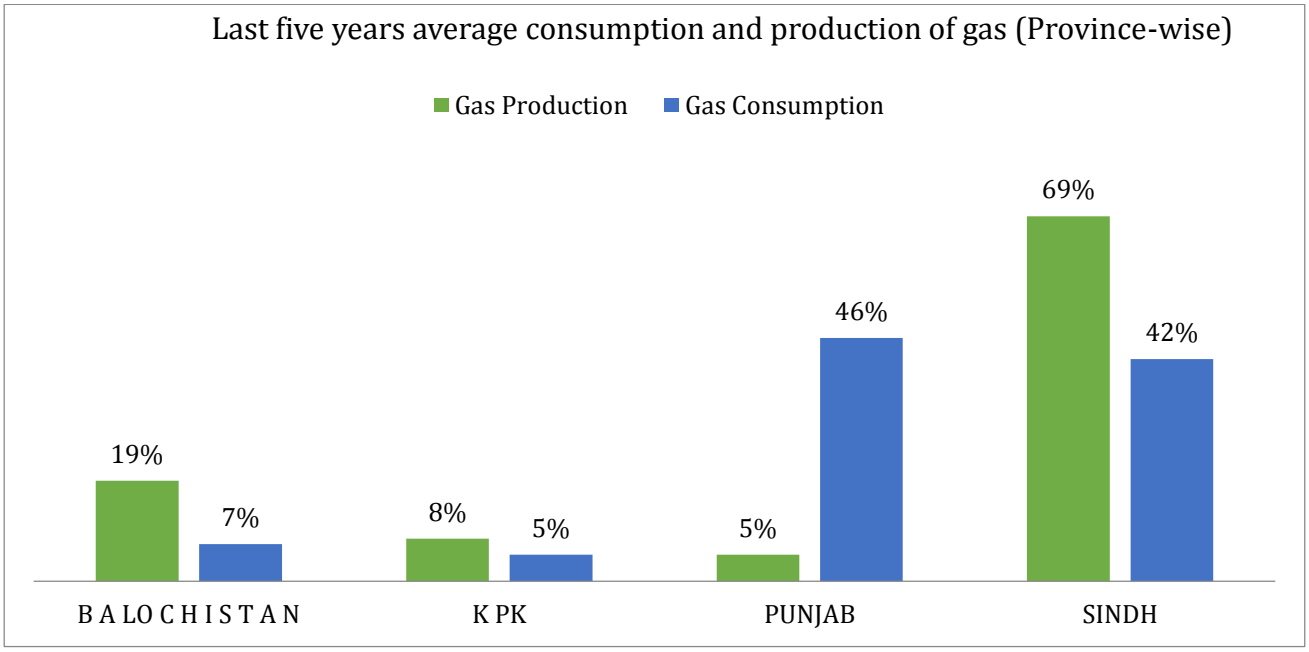

Figure 2. Consumption and production of gas (Province-wise).

Source: Economic Survey of Pakistan 2015.

In term of natural gas, Pakistan has most advanced gas transmission and circulation system worldwide. Gas is considered as a cheap and clean source of energy than oil (Toufiq, 2013) that is why its share in total energy is brought in Pakistan. The recent development in the country and present gap in demand and supply of gas indicates that present consumption pattern will not continue. To resolve the problem, there is need to use modern solution such as LNG, Biogas and Biomass for households (EGS, 2016). According to federal minister for petroleum and natural resources, Pakistan is presently facing 2 Billion cubic feet (BCF) natural gas shortfall per day that has hampered the economic and household activities, while it is expected that shortfall will be to the tune of 3 to 4 BCF by 2018 to 2020 (The News, 2016). The energy experts of (CPEC) China Pak Economic Corridor predicted electricity shortage will increase to 10,844MW by 2020, the annual electricity demand would increase by around 8 percent which would increase the overall demand for electricity to 27840MW and 31900MW by the year 2017 and 2020 respectively. Pakistan faced massive shortfall of electricity in 2015 i.e 7712MW and currently total installed capacity is 25552MW and total installed capacity would reach 26531MW to 29131MW in the year 2017 to 2020.

At present, in winter Pakistan face 4 to 6 hours load shedding in urban and 4 to 8 hours in rural area whereas in summer load shedding duration is almost 10 hours in urban and about 14 hours in rural areas which are very destructive for the economy as well as for common people (Ahmed et al., 2016). Awan & Khan (2014) described that energy played important role in economic development and reliable energy sources was necessary to improve standard of living of the people in the country. They found progress in industrial sector was very important in development of every country but it depends on reliable electricity supply. The people of Pakistan hit badly by the energy crisis since last two decades. The also found that one of the main reason for energy crisis was increasing prices of hydro carbon resources and lack of development and planning to increase the supply of energy in the country. This paper investigated that the renewable energy sources was very important to reduce the energy crisis. They

suggested that production cost of renewable energy could be reduced by providing tax incentives and import duty relief. Ozturk & Al-Mulali (2015)investigated link between the energy consumption and economic growth together with trade openness and the key GDP determinants was total labour force and gross fixed capital formation with the used of multivariate modeling GCC (Gulf cooperation council) countries moreover data was used from 1980 to 2012. The result showed that energy consumption in co-integrated with growth of GDP and also there was positive relationship between the energy consumption and GDP growth in long run by the use of (FMOLS) modified ordinary least square. Solarin & Shahbaz (2015) investigated the relationship among the consumption of natural gas and economic growth of Pakistan and including capital, foreign direct investment and trade openness for the period between 1971 to 2012 in Malaysia. They applied structural break unit root test to check the stationary and also applied combined coitegration test to check the long run relationship between variables and ARDL bound test was also applied to test long run relationship in existence of structural break. Results showed that gas consumption, Capital formation, foreign direct investment and trade openness had positive relationship with economic growth in Malaysia.

Bhattacharya (2015) investigated that wood energy played the key role to meet the energy demand in rural areas of India. The total share of wood energy in total consumption of energy was about 18 percent in the rural areas of the country. Wood mostly used as fuel, cooking in households and also in manufacturing and agro based processing. They examined that generation of bio power had been growing about 16 percent annul on average since Dec, 2005. This sector also faced uncertainty in future due to increasing cost and shortage of supply of wood. This paper concluded that the potential of bio power capacity which was based upon surplus of wood after meeting the demand for fuel wood and timber was calculated to be 180 to 260GW. Purwanto et al. (2016) examined the changing in the development of natural gas industry which contributes the economic growth and reduction in the reliance on petroleum products energy. This paper reviewed the situation of industry of natural gas in Indonesia, reserves of gas, supply for demand of gas, infrastructure, prices and regulation of natural gas. They identified hurdles and remedies for future development moreover, development of gas infrastructure had been slow and production of gas was reduced because gas fields very old and production of gas was not significant. The predicted results showed that gas demand of domestic consumers will increase significantly double to triple in 2025 than 2013. They suggested that to meet the demand of gas, Indonesia needs to attract the investors to invest in the future gas structures and exploitation of gas fields. Teller-Elsberg et al. (2016) examined electricity, gas, wood and heating was important for welfare of many households in America. Those people who spent 10 percent and more on energy services of their income could be consider as fuel poor. Data showed that about 71000 households suffered from fuel poverty in America in 2000 and this figure increased to 125000 in 2012.

Present energy trend in Pakistan is exceptionally inefficient for industrial as well as domestic sector, Pakistani households facing the serious problem of Sui gas shortage and it is very destructive for household's level main objectives of this research are to identify the to identify the share of total energy expenditures in household budget, alternate energy uses, there cost and the determinants of gas cost at household level..

METHODOLOGY

Descriptive statistics technique was used to find out the percentage and frequencies of collected data through this formula. ($AM = \sum X / N$) and percentage was calculated with following formula.

$P = F / N * 100$

Multiple and Binary Logistic Regression techniques were also used to analyze the data in current study.

Multiple Regression

$$Y_{GE} = f(\alpha + \beta_1 x_{1FS} + \beta_2 x_{2\,I} + \beta_3 D_{1\,H} + \beta_4 D_{2\,G}) \qquad (1)$$

Where Y= Gas Expenditures, x_1= Family Size, x_2= Income, D_1= Heater, D_2= Geyser

$$Y_{WTP} = f(\alpha + \beta_1 x_{1\,\text{Income}} + \beta_2 x_{2\,AC} + \beta_3 x_{3LSH} + \beta_4 D_{1\,H} + \beta_5 D_{2\,FD}) \quad (2)$$

Where Y= Willingness to pay, x_1= Income, x_2= alternate Cost, x_3= Load Shedding Hours,

D_1= Health, D_2= Family Disputes

Binary Logistic Regression

For binary logistic regression analysis following model and variables were used

$$Y_{ANT} = f(\alpha + \beta_1 x_{1\,LSH} + \beta_2 x_{2\,I} + \beta_3 D_{1EOJ} + \beta_4 D_{2\,CGST} + \beta_5 D_{3GJT}) \quad (3)$$

Where Y= Alternatives, x_1= Load Shedding Hours, x_2= Income, D_1= Effect on Job,

D_2= Children Going School Timely, D_3= Going Job Timely.

RESULTS AND DISCUSSION

Figure 3 indicates the combine share of total energy expenditures in households budget, data showed that with the use of Vehicles average Rs.1220 Rs.2376, Rs.4485 and Rs. 7839 spend by the households who have their income level less than Rs.25000, Rs.25000 to Rs.50000, Rs.50000 to Rs.75000 and Rs.750000 and more respectively. Coal was using by the households who have their income level less than Rs.25000 and Rs.25000 to Rs.50000 and they were spent on Coal average Rs.190 and Rs.282 respectively while income from Rs.50000 to Rs.75000 and above did not use coal and Generator was not used by the households having Income level less than Rs.25000. Geyser was used by all income groups in current study, data shows that average Rs.225, Rs.690, Rs.735 and Rs.780 were spent by households with all income groups respectively.

The sui gas bill in summer on average was Rs.218 who had monthly income less than Rs.25000, Rs.416 who had monthly income between Rs.25000 to Rs.50000, Rs.634 who had monthly income between Rs.50000 to Rs.75000 and Rs.1007 who had monthly income Rs.75000 and while sui gas bill in winter on average were Rs.392 who had monthly income less than Rs.25000, Rs.695 who had monthly income between Rs.25000 to Rs.50000, Rs.1137 who had monthly income between Rs.50000 to Rs.75000 and Rs.1902 who had monthly income Rs75000 and more. The Electricity bill in summer on average was Rs. 2838 who had monthly income less than Rs.25000, Rs.5178 who had monthly income between Rs.25000 to Rs.50000, Rs.8000 who had monthly income between Rs.50000 to Rs.75000 and Rs.11595 who had monthly income Rs.75000 and while electricity bill in winter on average are Rs.827 who had monthly income less than Rs.25000, Rs.1637 who had monthly income between Rs.25000 to Rs.50000, Rs.2298 who had monthly income between Rs.50000 to Rs.75000 and Rs.13857 who had monthly income Rs75000 and more.

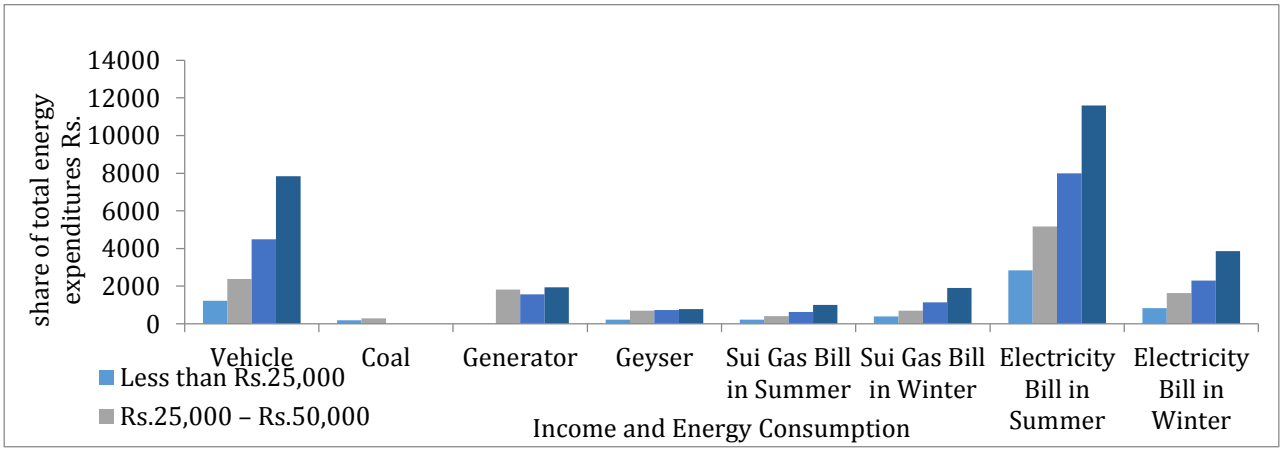

Figure 3. Combine share of total energy expenditures in househaaold budget.

Table 1 shows that 8 percent households were facing upto 9 hours sui gas load shedding in the day, 44 percent households were facing 10 to 19 hours sui gas loading daily and 48 percent households were facing 20 hours and above sui gas load shedding daily. Data showed that large numbers of households were facing 20 hours and above sui gas loading shedding daily in winter.

Table 1. Number of hours gas load shedding per day.

LSH	Frequency	Percentage	Average LSH
Upto 9	12	8	8
10 to 19	66	44	16
20 and Above	72	48	21
Total	150	100	17.5

Figure 4 shows average monthly cost associated with the use of alternatives in case of sui gas load shedding and shortage, figure indicates that about Rs. 3000 cost was associated with the use of Cylinder, over Rs.1000 cost was associated with the use of Oil Stove, about Rs.2000 cost was associated with the use of Wood Fire, when households prefer to Purchase from Bazar the cost would occur over Rs.7000 and when households were using Cylinder plus Purchase from Bazar as alternate source then the cost would occur over Rs.5000, while over Rs.4000 and about Rs.3000 average cost associated with the use of alternates like Wood Fire plus Purchase from Bazar and Oil Stove plus Purchase from Bazar respectively. The data shows that highest cost associated if households were preferred Purchase from Bazar as alternate source to overcome the painful situation of sui gas load shedding and shortage.

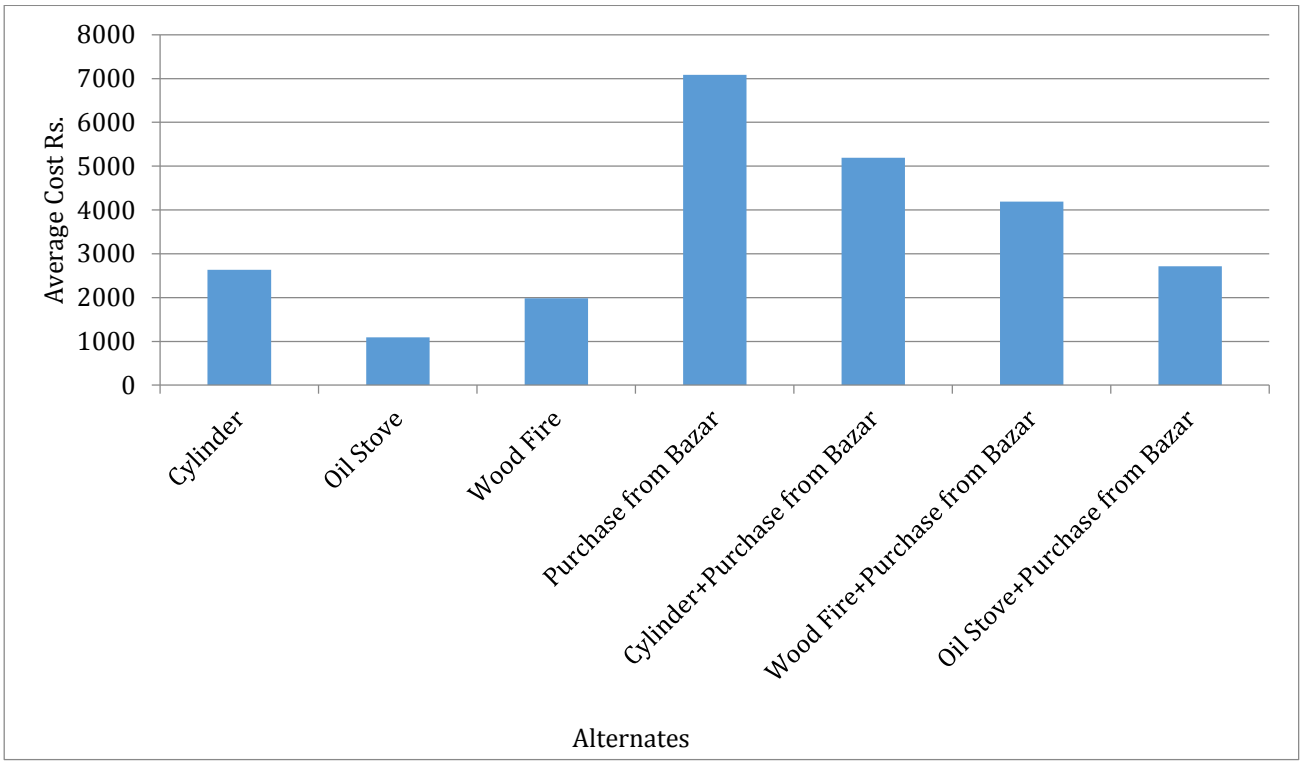

Figure 4. Alternatives used and it's average monthly cost.

Figure 5 showed that households with income level less than Rs.25000 were willing to pay above Rs.400 extra for uninterrupted sui gas supply, households having income level between Rs.25000 to Rs.50000 were willing to pay about Rs.700 extra over tariff and households with income level Rs.50000 to Rs. Rs.75000 were willing to pay about Rs.1100 extra over tariff for uninterrupted sui gas supply while households with income level between Rs.75000 and above were willing to pay Rs.1000 extra over tariff

for uninterrupted sui gas supply. Data showed that large number of households were willing to pay extra over tariff about Rs.1100.

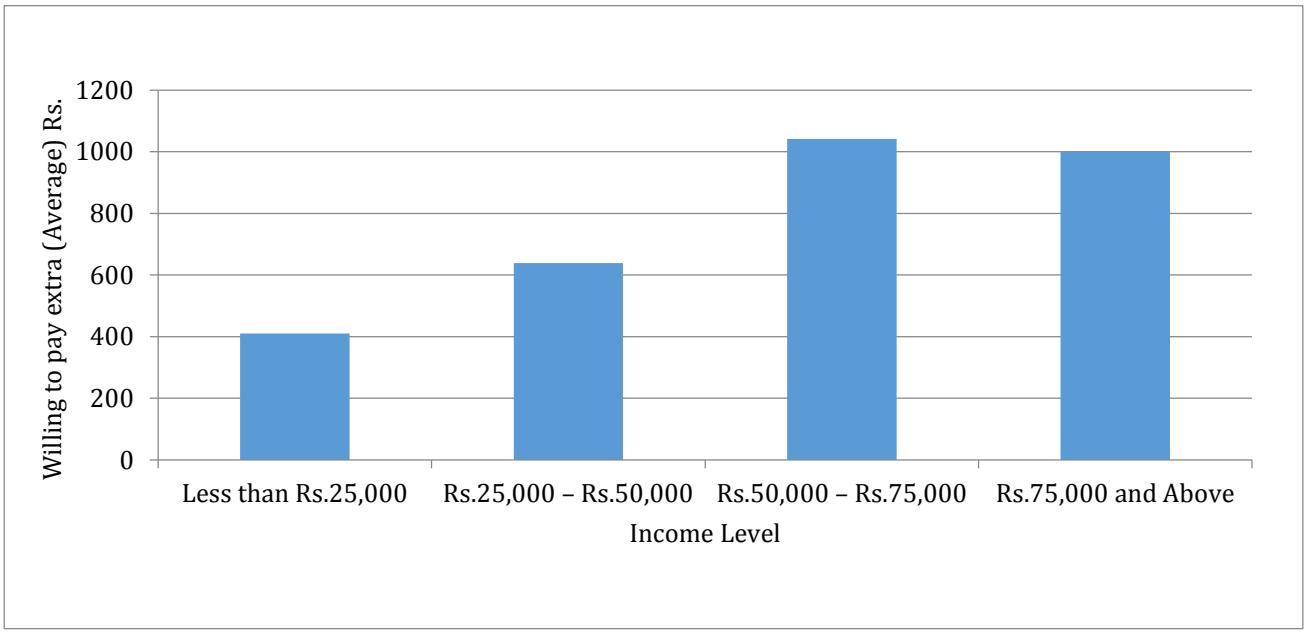

Figure 5. Income level and willingness to pay extra over tariff.

Regression analysis was used to explain the gas expenditures of the respondent households and these results are presented in Table 2 according to the results, if family size increases by one member than gas expenditures will increase by Rs. 57 on average holding other variables constant. if income increases by 1 rupees then gas expenditures will increase by .010 rupees on average holding other variables constant and if use of the heater increase then gas expenditures will increase by Rs.979 `holding other variables constant similarly if use of the geyser increase then gas expenditures will increase by Rs.779 holding other variables constant. Data showed that all the independent variables have positive and significance impact on gas expenditures at 1 to 5 percent level of significance.

Table 2. Gas expenditures- regression analysis.

Variables	β's	Std. Error	T - Value	Sig.
Family size	57.40	25.67	2.23	.027
Income	.010	.003	2.91	.004
Heater	978.85	165.35	5.92	.000
Geyser	779.43	164.26	4.74	.000
R- Square = .649	Adjusted R Square = .640			

Regression analysis was used to explain the willingness to pay of the respondents to pay extra amount in gas bill in case of load shedding. These results are presented in Table 3. Results showed that 1 rupees increase in the income of the households leads to increase in the household's willing to pay by .002 rupees on average holding other variables constant, if alternatives cost increase by 1 rupees then household's willingness to pay will increase by .093 rupees on average holding other variables constant similarly if 1 hour of load shedding increase then household's willingness to pay will increase by Rs.15 on average holding other variables constant, if health cost increase by 1 percent then it will leads to increase

household's willing to pay by Rs.92 on average holding other variables constant and if family disputes increase then it will lead to increase household's willingness to pay by Rs.150 on average holding other variables constant. Results showed that there are positive and significant relationship among the dependent and explanatory variables at 1 to 5 percent level of significance and R square .74 and adjusted R square .73 indicating overall model is good and all the important variables included in the model.

Table 3. Willing to pay extra- regression analysis.

Variables	β's	S.E	T - Value	Sig.
Income	.002	.001	2.38	.019
Alternate cost	.093	.009	10.03	.000
Load shedding hours	15.96	5.49	2.90	.004
Heath	92.71	45.94	2.018	.045
Family disputes	150.75	46.30	3.25	.001
R- Square = .760 Adjusted R- Square = .751				

To estimate the impact of the explanatory variables like load shedding hours (LSH), income, effect on job (EOJ), children going to school timely (CGST) and people going to job timely (GJT) on dependent variable, Logit model was used. Results showed in Table 4. Explanatory variables LSH, income, EOJ and GJT are positively and significantly influencing the use of alternatives holding other variables constant while CGST has no impact on use of the alternatives.

Table 4. Results of Logit Model.

Variables	B	S.E	Wald	Sig	Exp(β)
LSH	.311	.063	24.44	.000	1.364
INCOME	.000	.000	4.56	.033	1.000
EOJ	1.244	.590	4.44	.035	3.469
CGST	-.345	.563	.375	.540	.708
GJT	1.114	.522	4.55	.033	3.048
Constant	-3.378	1.142	8.753	.003	.034

CONCLUSIONS

According to the data, it is concluded that the households used vehicles, coal, generators and geysers in study areas, which indicates the share of total energy expenditures in the household budget and as level of income increase, then level of energy consumption also increase. Households were bearing 19 to 20 hours gas load shedding in winter. So people used different alternatives to meet their daily breakfast, lunch, and dinner needs. For uninterrupted Sui gas supply, households are willing to pay extra over tariff. The result of regression analysis indicated that there was positive and significant relationship among the variables. In addition dependent variable (willingness to pay) also had positive and significant relationship with the

explanatory variables. The binary logistic model results showed that explanatory variables were positively and significantly influencing the use of alternatives while CGST had no impact on the use of the alternatives.

This research suggested that an awareness campaign should be conducted for energy saving at the household level, particularly for two main sources of energy i.e., sui gas and electricity reducing the reliance on CNG vehicles and transport systems by developing a good and efficient transport system. The process of importing natural gas by Iran, Pakistan, India and Turkmenistan, Afghanistan, and India pipelines should be quick, high cost of fuels should be reduced so that people may avoid using cheap CNG vehicles, gas theft should be stopped by producing the good and efficient monitoring system and government should adopt new investment policies to attract the foreign investors in the gas sector.

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