Are Women Better Energy Managers in a Developing Country?

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Abstract

Energy Management at household level is multifaceted issue due to factors involving gender, education and awareness to energy usage. This study was conducted in Peshawar city, Pakistan which is capital city of the province and densely populated. This study identifies the role of women in energy management at household level keeping in view household's characteristics in an underdeveloped country. The key factors included were (1) education and job status (2) characteristics of nuclear and joint family system (3) energy consumption pattern of the households and (4) awareness of energy management and its implementation amongst the females in the household. One-way ANOVA test shows that women spend more than three hours while utilizing energy appliances. In addition, awareness of high billing cost per unit, electricity consumption during peak hours' unit, idea of renewable energy sources and their use cum awareness level was found to be extremely low. The results show that the education of husband and wife is indistinguishable and the females are the major decision makers in carrying the household chores. Males are the sole bread winners of the house and majority of the females are housewives despite of attaining higher education. Despite the fact that women are aware of household energy management, there is still a

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need for full implementation and awareness among women in the household. Lastly, trend of nuclear family system is making pace in the Pakistan and energy management and utility bills are handled independently. The results can be used for policy making in developing countries.

Keywords: Household energy management, energy saving, unseen labor, household appliances, energy consumption.

1 Introduction

Pakistan is facing short-fall of power output around 6500 MW in the form of black outs and consumption of energy sources has tremendously crossed the indigenous supply [1]. Pakistan is now in import economy zone with its oil import bill is about 9.1 billion dollars. Finance Division [2] reported that 79% of oil and natural gas is consumed to fulfil Pakistan's energy need. Energy management and energy conservation are one of the most environment friendly solutions. Energy is consumed at household level by all members including husbands, wives and children. The domestic energy consumption in Pakistan levy the fact that residential sector is one of the major energy consumption sector and has a peak value reaching the 25.20% in between the year 2012–2013 [3]. Similarly, the energy consumed at the household sector in the United Kingdom (UK) is reported to be 29% [4].

From a gender perspective, the roles of householders are differentiated into roles of men and women [5]. Energy and gender are correlated because female take up the burden of fuel or electricity and the situation gets worst when there is unavailability of fuel or frequent blackouts affecting their health and safety. In addition, gross income, personal attributes, person in charge of household expenses, and awareness to energy management are key factors for the energy consumption at household level [6]. One study reveals the fact that technology has provided relief to females running household [7]. For instance, household energy consumption study carried out in the Bandung City, Indonesia shows that women are more cautious than men when it comes to energy consumption, household expenditures and women are good energy managers when it comes to energy savings [8]. On the other hand, female headed homes in United State, Texas, the electricity and gas consumption is more than the male running the households [9]. More so, in Dutch, households the females use more natural gas for fulfilling thermal requirement for routine chores rather than males.

1.1 Conceptual Framework of the Study

The consumption of energy at demand side especially at households solely involves the proper decision making as human activities are being carried out the full day at home. The conservation can be done in different ways but involving women in such practices of energy management is not being fully assessed in developed as well as developing countries. Household energy consumption is a complex process driven by various individual and situational foretellers [10]. Permana, Aziz [8] argued that sharing of house actually means the sharing of energy usage among personnel's and this also accounts for the consumption of energy being consumed more by the person living alone in a house with same living standard as two people house and subjected to availability of energy outages [11, 12]. Wilk [13] reported that household decision making process is complex and is individual's way of thinking. Relating the household energy consumption with women participation in domestic sector can clarify the picture of behavior of women with respect to household appliances and her awareness level with respect to energy management.

This study examines whether women can play role as energy manager and their effect upon family decision-making in household energy consumption. This study hypothesizes that there is a strong correlation between decision makers in the households and energy consumption. Based on socio-economic conditions, can wife (woman) be the best energy saver in the household in developing countries? The study expects to clarify gender attributes affecting household energy conservation and elucidate the roles women and men in residential energy savings. Keeping in mind the fact that Peshawar district of Khyber Pakhtunkhwa is a province of Islamic Republic of Pakistan where religious, cultural and social norms are part of Islamic society, where women are given respect in their religion but cultural practices has increased the gender discrimination over the period of time as proved by other studies as well [8, 14]. This study is one of the many attempts correlating the women behavior with energy management practices conducted in developed and many developing parts of the world [8, 15, 16] and first of its own kind conducted in Peshawar district of Khyber Pakhtunkhwa province of Pakistan.

In addition, three hypotheses were applied on the data. To find the nexus between income level and its distribution among the Nuclear Family members the monthly income and number of members were subjected under the One-way ANOVA test and it was hypothesized that the Income level is not in compliance with the members. Else, the Income level and the total members

are adjustable with each other. The second hypothesis for One-way ANOVA analysis was that women working hours are three or less than 3 hours per day. Else, results in the utilization of more gas stove which results into the energy consumption which is ultimately added into the economy of nation. The third hypothesis for the One-way ANOVA test states that, by knowing the timing and trends of basic energy use and the idea of renewable energy in household appliances, we can predict that women are better managers of household energy or that the concept of energy management among female households is weak.

2 Methodology

This study has been executed in Peshawar, Khyber Pakhtunkhwa formerly known as North West Frontier Province (N.W.F.P) shares its borders with other provinces of Pakistan. Peshawar Division has the population of 7,403,817 which is 24 percent of the entire population of KP Division and is the second large division. The reasons for choosing Peshawar was that it is the capital city of the province with considerably significant economic growth. Second, Peshawar is a historical city and the culture of communities strongly dictates family decision making system. The women are mostly house wives thus making them energy manager at household level.

2.1 Questionnaire Distribution Criteria

With an objective of grasping data of household women involvement in energy management practices, for the very first time this research study

Figure 1 Peshawar city and survey areas [17].

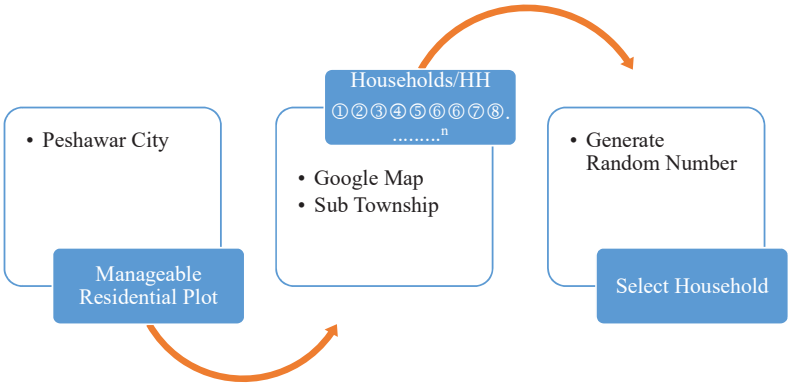

Figure 2 Random selection criteria of respondents (Source: Adapted from [8]).

was conducted in July 2019, during the peak summer season in Khyber Pakhtunkhwa province. The survey questionnaire was randomly distributed by hands across the different areas of Peshawar District/Tehsil clearly explained in Figures 1 and 2. These tehsils represent the multifaceted data including level of education, family system, energy availability in the area and family economics for paying energy bills and decision making. Such wide selection of areas provided data for understanding the different levels of classes in Peshawar and their behavior towards energy management. The random selection criteria is adopted from similar research study carried out in the Bandung city of Indonesia [8]. The randomly selected houses are retrieved from the Google map of Peshawar (https://www.google.com/maps). In a population of 4,269,079 with confidence level of 95% and 8% of error tolerance the expected sample size of questionnaire came out to be 150 and by this calculation a total of 300 questionnaires were distributed. The survey questionnaire had four sections and the corresponding sections includes the information about Household Characteristics, Family System Characteristics, Household Appliances Information and Awareness to Energy Management. A total of (58) questions were inquired out of which (12) questions were closed ended, (42) were multiple choice questions and (04) questions were kept optional for the respondents to respond if they opted so.

2.2 Data Collection and Removing Mischievous Responses

In order to get stable, consistent and reliable results the survey questionnaire should be free from the different types of respondents such as outliers, mischievous respondents, fake respondents etc. To get the most accurate

Table 1 Two mischievous responses with extreme high and extreme low mean and variance values [18]

Mischievous Respondent	Mean	Variance
Respondent 21	1.9706	3.181
Respondent 128	17	824.667

results and valid data an algorithm named as the distribution-free, sample-size- unconstrained, backward-stepping MR is applied here [18]. For the data analysis and applied algorithm SPSS software and Microsoft Excel were used [8, 18] and [19]. The data was collected manually from each respondent and a total of (134) questionnaires were received out of (300). Using the SPSS and MS Excel (134) responses are subjected to analysis and two variables were found to come under the Mischievous Response category as depicted in Table 1.

It is noteworthy that this study does not completely identify all the parameters which are accountable in energy consumption pattern of overall households' appliances. Noticeably this exclusive study did not account for all parameters reflecting the family system characteristics where people like to dwell in. The religious norms are unquestionably the same for Muslims but demographics, psychographics and sociographic of KP are quite different from those of other provinces like Punjab and Sindh therefore, similar study can have different emerging results from other parts of the country.

3 Results and Discussion

3.1 Attributes of Respondents

Initially, household Information and profile of the respondent in general was analyzed. It was observed that most of the female respondents belonged to Peshawar city while other responses were from nearby districts of Peshawar such as Mardan, Dir, Sawabi, Kohat. This indicated that people prefer to stay in bigger cities to pursue education and (or) seek job. Thus, population and stress on energy resources increase. An annual population growth of 3.29% is depicted by of the World Population Prospects for Peshawar District (Retrieved from https://www.macrotrends.net/cities/22051/peshawar/population). In terms of education, 56.8% of the respondents had completed higher education i.e., minimum 16 years and above. It was noted that about 4.5% of respondents had no education. The perusal of education was an indication of awareness and grooming of female community in Peshawar district. These

Table 2 Brief discussion of household information

	Frequency	Valid Percentage
Place of the Respondent		
Respondents from Peshawar District	94	71.9
Respondents from other Districts	37	27.3
Prefer not to answer	1	0.8
Total	132	100
Education of the Respondent		
Basic Education	47	37.6
Higher Education	71	56.8
No education	7	4.5
Prefer not to answer	7	1.1
Total	132	100

results are tabulated in Table 2. It can be inferred that higher education can be a tool for better decision making at household level. Bakewell and Mitchell [20] reported nine personality traits among male and female for decision making process. While male is bound to time-restricted decision making, females take time for decision making.

3.2 Working Hours of Women

Women unseen and unpaid labor is never being appreciated and encouraged. This unseen labor in terms of economics is actually the use of human capital to produce non-human capital i.e. working with the appliances. Together this labor and capital gives an output in the form of services and tools ready for the members of the household [21].

Hypothesis 01:

A second hypothesis has been made in this regard, the findings of which are shown in Table 3. The Null Hypothesis states that women work three or less than three hours a day, and the alternative hypothesis shows that women work hours if more than three is an indicator of more gas stove use that ultimately results in energy use, which is eventually added to the economy of the country.

According to One-way ANOVA test in Table 3 as the p value is less than the significance value i.e. $0.00 < 0.05$ The null hypothesis is dismissed and

Table 3 One-way ANOVA test for the women working hours and use of gas stove

	Sum of Squares	df	Mean Square	F	Sig.*
Between Groups	33.560	2	16.780	57.259	0.000
Within Groups	35.752	122	0.293		
Total	69.312	124			

*Significance level = 0.05.

the alternative hypothesis has been proved that if the working hours of women are longer than three hours, it would eventually increase the usage of the gas stove, which increases energy consumption and ultimately contributes to the economy of the country. This demonstrates the intangible and priceless contribution of women to the household economy as well as to the economy of the nation.

From these test results, it can be inferred that the commitment of household women to household chores is more than three hours a day, which, in turn, also suggests their use of gas-based appliances. This is how the pressure on the ancillary energy grid is affected indirectly. This is also a proof of relation of women with energy.

3.3 Characteristics of Nuclear and Joint Family System

In developing countries, household are comprised of either joint or nuclear family. This changes the dynamics of energy usage patterns and overall economics [22]. According to this study, in a nuclear family system 55% respondents revealed the fact that only the husbands are the utility bill payer of the house and 49% of the respondents have shown the males to be the only bread winner of the house as shown in Figure 3.

Hypothesis 02:

Characteristics of Nuclear and Joint Family System have been subjected under the analysis where major outcomes are observed. Table 4 describes the results of hypothesis No. 1. According to the ANOVA test in Table 4 the monthly Income of the Nuclear family is not in compliance with the total members in Nuclear Family System which indicates the burden upon the sole breadwinner of the household. It states that the p value is greater than the significance level i.e. $0.154 > 0.05$ which qualifies the Null hypothesis and states the fact that the bread winning with only one person from the household does not fulfill the needs of a nuclear family system. However, these findings specifically contradict the alternative hypothesis that the household income level and the members is the household are in line with each other.

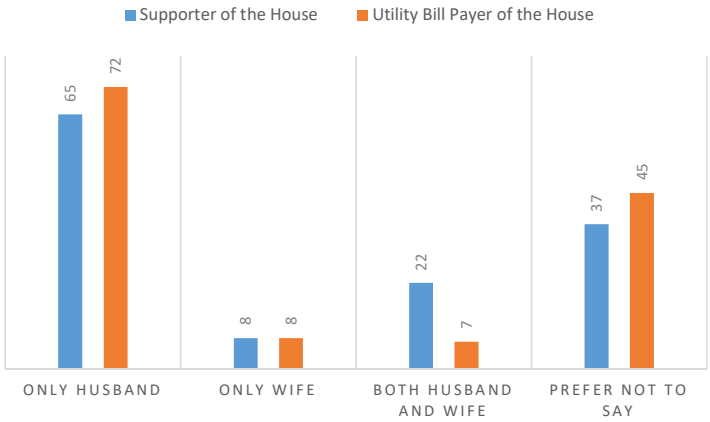

Figure 3 Utility bill payer and breadwinner in nuclear family system.

Table 4 ANOVA test for income level vs number of people in the nuclear family system

	Sum of Squares	df	Mean Square	F	Sig.*
Between Groups	56.491	2	28.246	1.914	0.154
Within Groups	1224.730	83	14.756		
e Total	1281.221	85			

*Significance level = 0.05.

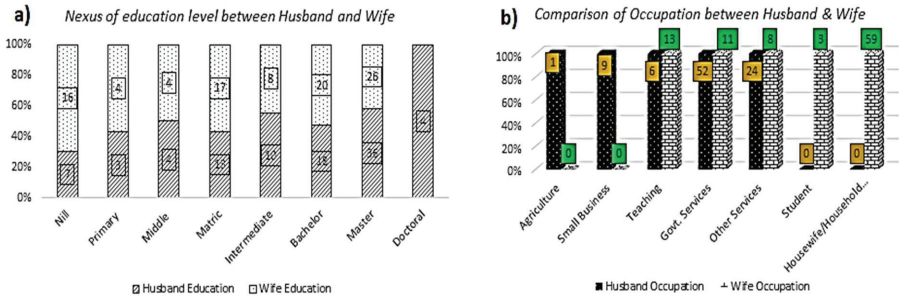

Figure 4 (a) Comparison of education of husband and wife in nuclear family system, (b) comparison of occupation of husband and wife in nuclear family system.

When the education of both the husband and the wife was inquired, it was discovered that the standard of education was indistinguishable till the Masters or Bachelors. These results are identified in Figure 4(a).

According to the analysis the occupation of the male is mostly Govt. Services (52/92) and Other Services (24/92) whilst the females are responsible for the running the households only (59/92) as shown in Figure 5. 75/90

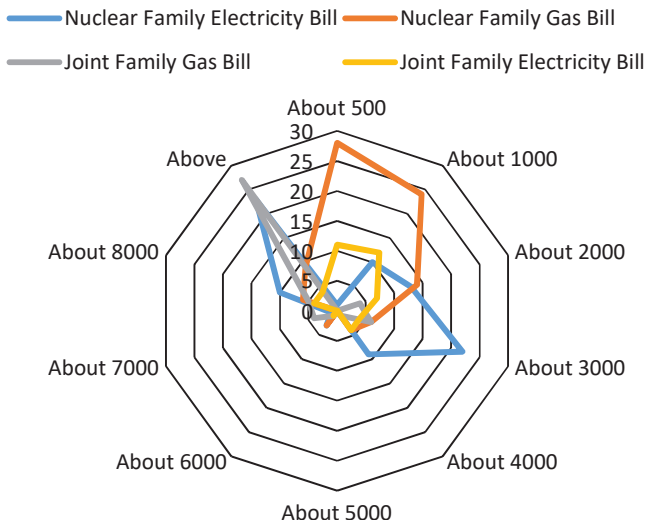

Figure 5 Utility bills of nuclear and joint family system.

(83.33%) there are on average four or more than four members living in a Nuclear Family System. The average monthly income of the Nuclear family system is 50,000 PKR or above as according to 31/91 (34.1%) or (USD 321.08) as in Figure 5. In a Joint Family System 23/49 the total number of families is two (02) and maximum family members range is in between 05–10 members and the graph slowly declines to 11-20 members Figure 6.

In the single family system, the monthly gas bill is in between Rs.500 – Rs.1000 and for the joint family system that average monthly Gas Bill is Rs.1000. In a Nuclear Family System is it is marked that average Electricity Bill is Rs.3000 and Rs.8000 or above in contrast with the Electricity Bill of Joint Family System which is Rs.8000 Figure 5.

Main conclusions drawn from this section of the questionnaire are (1) In eastern culture specifically in Pakistan there is a greater concept of people choosing to live in Joint Families and share commodities but now the trends are inclined more towards Nuclear Family System. This shift however is either a reflection of adoption of western culture or changing in the priorities of the people for their family choices. (2) Education of the husband and wife is indistinguishable till perusal of 18 years of education but none of the females participate to continue for doctoral studies. (3) Husbands are the sole breadwinners of the family and are responsible for paying the utility bills and other expenses of the house. (4) Females are managing the households

and decision-making is in the hands of woman. (5) Unemployment is more in Peshawar, KP [23], due to the small geographical area of the province and no industrialization, males are recruited mostly in the Govt. Sector and teaching domain. Whereas a small peak is seen for business and other sectors. (6) People who are living in Joint Families share the utility bills and each family in the house is responsible to bear their own household expenses.

3.4 Energy Consumption Pattern and Decision Making

The behavior of a person widely effects the household energy consumption [24]. This second section of the research questionnaires dealt with all the electricity appliance usage that women deals all day long for carrying routine chores. Statics for kitchen based and home-based appliances along with their usage frequency per day and its cost per kWh has been calculated.

It is noteworthy that each appliance corresponds to different energy consumption value depending upon its size, specifications, model number and number of times it is used in a day and manufacturing company. For example, microwave oven may consume 600 watts to 1700 watts. It is used for multiple purposes but major of its usage is for reheating the food or to heat frozen food. This might take a maximum of 2–3 minutes and as per our analysis its usage frequency is more than three times a day. Other than the kitchen-based appliance the routinely used appliances such as bulbs, ceiling fans, washing machine, iron and air condition are also examined.

The analysis has been carried out in peak summer season and the use of appliance such as air condition and fan is mostly at peak during summer season. Moreover, the respondents show the load shedding is maximum for four (04) hours and eliminating these hours from appliances usage as a general estimate the air condition is used 2–3 hours during day time and 4–5 hours during night time. Taking the average of these estimates a total of (07) hours air condition is used also the peak summer season starts from May to September but the need for air condition is felt in the months of June, July and August i.e. for (03) months.

For the ceiling fans, they are used frequently from May to September all the day long i.e. 20 hours. The light bulbs are used mostly after the evening normally from 7pm to 12am during the summer season as the days are lengthy during summer. A very few of the bulbs are used during day time depending upon the building structure. All the statics for the aforementioned appliances is given in the table and to calculate the electricity cost per kWh the NEPRA tariff [25] has been used to get the latest information about the electricity

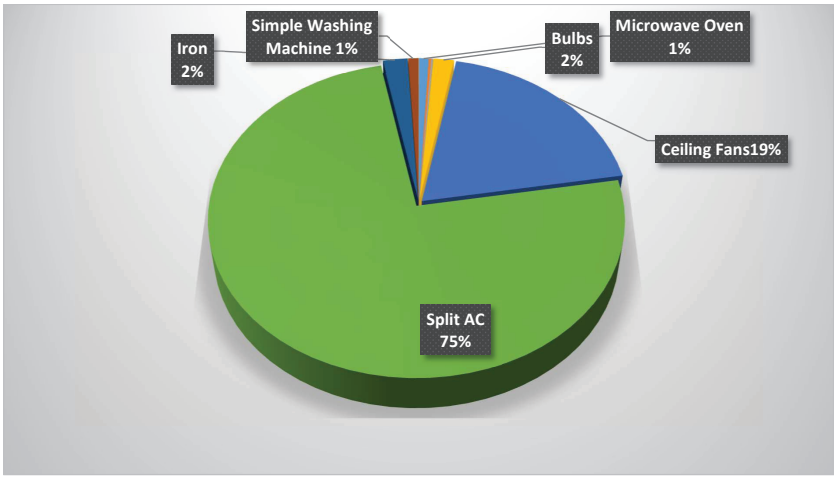

Figure 6 Energy consumption pattern of the household basic appliances.

bills. Also, the units consumed in the most recent month has been investigated through an electricity bill of a randomly selected respondent. All the power consumption of appliance information has been investigated through the K Electric official website Retrieved from (http://www.ke.com.pk/sustainability/energy-conservation/ec-calculator/).

Figure 6 shows the energy consumption pattern of the household. The peak for AC and light bulbs is monitored which is obvious because in peak summer season the use of Fan and AC is common. Eliminating the load shedding hours, the monthly electricity and gas bill range is in line with the electricity and gas-based appliances usage because their frequency is nominal.

Conclusion drawn from this section of the analysis are (1) Use of air condition is mostly in the month of summer but instead of using 1 ton split AC if people use 1 ton Inverter AC could save 40% of electricity bill Retrieved from (http://www.ke.com.pk/sustainability/energy-conservation/ec-calculator/). (2) Use of light bulbs whose consumption is rather not too much i.e. only 2% but a wise decision is to use LED bulbs instead of energy savers. (3) Energy consumption of kitchen based appliances like toaster, blender and microwave oven does not significantly contribute to monthly electricity bill. It can be deduced that the monthly pattern of usage of basic household appliances barely exceeds the higher kWh limits, however, a proper management tool is needed to keep utility bills that do not exceed a certain amount in PKR.

3.5 Energy Management Awareness at Household Level

The last section of research questionnaire deals with all the queries related to awareness level of respondents towards energy management. Different definitions of energy management can be found in different studies. According to one of the definition energy management is basically comprised of the planning, action and execution of a predefined task with minimum amount of energy to be input [26]. In this paper before digging deep into the energy management practices its awareness amongst the people makes a significant difference during its implementation. The scope of our research is Khyber Pakhtunkhwa, Peshawar district mainly and specifically female gender to acquire about the energy management awareness in the household. To get an idea of female's interest level towards energy management a total of (18) questions are cross-examined in this section out of which (10) questions are closed ended and remaining (08) are multiple choice questions. A brief discussion of the questions is explained in Table 5. The results of the questionnaire are not in compliance with the energy management practices as well as awareness level amongst the household females.

Hypothesis 03:
Null Hypothesis*

To check the energy management practices in the households the awareness level of EnM is investigated and being inspired from similar studies [8] hypothesized that the awareness level regarding EnM is at good rank and known up to some extant to the energy consumers in the Households. Alternatively, the awareness level of Energy management is poor among the dwellers of energy consumption personnel's.

Table 5 One-way ANOVA test of energy management awareness at household level

	Sum of Squares	df	Mean Square	F	Sig.*
Between Groups	10.52	10	1.053	6.016	0.000
Within Groups	18.55	106	0.175		
Total	29.07	116			
Between Groups	12.30	10	1.23	8.244	0.000
Within Groups	15.81	106	0.149		
Total	28.12	116			

*Significance level = 0.05.

Table 6 Energy management parameters to be investigated within the households

Descriptive Statistics						
Awareness parameter	N	Min.	Max.	Mean	Std. Deviation	Variance
Power consumption of electrical appliances	129	1.00	2.00	1.44	.498	.249
electricity load shedding pattern	130	1.00	2.00	1.20	.401	.161
cost per unit of electricity during the peak hours	129	1.00	2.00	1.49	.501	.252
energy saving information provided	129	1.00	2.00	1.44	.498	.249
Turn off the light in vacant rooms	130	1.00	2.00	1.07	.267	.072
Turn off the fan/fans in Vacant rooms	130	1.00	2.00	1.03	.173	.030
Ads being aired at TV channel	130	1.00	2.00	1.34	.477	.228

In Table 6 as the p value is less than significance level i.e. $0.00 < 0.05$ which rejects the null hypothesis* and qualifying the alternative hypothesis, therefore, it may be concluded that the awareness level of Energy Management is not significantly known among the females. This is also evident from the inclusion of renewables in the domestic sector during the blackout hours or load shedding. Almost 50% of the females wait for recovery of light to cover routine chores and almost nearly equal 47% of the females do the time management in case of electricity load shedding. Another important result is associated with the gas and electricity load shedding and alternate source used during these hours.

Table 6 shows that hours of load shedding in Peshawar district is maximum (04) hours and the alternate source used during gas load shedding is gas stove while that used during electricity load shedding is UPS. The (10) closed ended questions are discussed as 49% of the women are aware of high billing cost during peak hours. 54% of the respondents are aware of energy saving information provided on the utility bills.

Conclusions drawn from this section are (1) Women are least aware of energy savings by doing proper management and wise decision making at households. (2) Females are aware of hours of electricity and gas load shedding in their area so instead of waiting for electricity recover and gas

recovery women know how to manage routine chores. (3) People have idea of renewable energy resources but they are slowly moving towards renewables as indicated by the results where UPS is frequently used as an alternate source during electricity load shedding instead of Solar powered UPS with higher efficiency [27].

4 Conclusions

The conclusions drawn from this study are that females are aware of hours of electricity and gas load shedding in their area so instead of waiting for energy availability, women manage their routine chores. However, 50% of females have no other energy source and tend to wait for energy availability from the grid. In addition, Women are least aware of energy savings by doing proper management and wise decision making at households. To summarize, first hypothesis showed that the burden of paying energy bills was upon the sole breadwinner of the household despite living in a joint family system. The second hypothesis confirmed that women spend more than 03 hours of energy use per day. Whereas, third hypothesis showed women were aware of alternative equipment to fulfil energy demand but they were least informed about energy savings and management practices. In addition, it was also concluded that the pattern of energy use of routine electricity and gas appliances does not exceed the kWh limits, but that careful management is needed to keep bills constant every month. While it is known that the working hours of women are more than three, the realization that they are connected to the national energy grid still needs to flourish within the female household. This study clarifies that, while female knowledge of household energy management is known, it has not been completely achieved, therefore, only this study alone cannot address this question that women are currently fully aware of energy management.

Appendix A

Energy Consumption Calculation (Energy Consumption Pattern and Decision Maker in the Household)

Step by step procedure for measuring cost of appliance per month is explained below.

Step 01: Calculate Watts per day (watt-hours)-This can be done by simply multiplying wattage of the device to the number of hours used per day.

Step 02: Convert watt-hour to Kilowatts. As the electricity is measured in kWh so simply divide the value obtain in step 01 by 1000. This will give reading in kWh per day.

Step 03: Find usage over per month. In this step multiply the value obtained in step one by 30.

Step 04: Cost per month: For the final step, refer to the last electric bill to see how much we pay per kWh, i.e. electric rate. For example, according to the bill, the electric rate is 17.60 Rs per kWh refer to according to units consumed per month. Multiply this electric rate by the monthly usage of appliance (step 03) to find out how much our appliance is costing in a month.

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