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Role of Women in Energy Management at Household level in Peshawar, Pakistan

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***Abstract*—** Pakistan is an energy stressed nation and is currently facing short-fall of power output around 6500 MW and is among those countries which are mostly affected from climatic changes in the past ten past years i.e. from 1998 to 2017. To cater the aforementioned energy and environmental concerns, this research study is fabricated to (1) figure out the awareness level of females in regards to energy management (2) women behavior towards utilization of renewable energy resources in the households (3) females response to the changing energy conditions as a result of power outages in the household setting and (4) energy management strategies conducted at the households. The scope of the study is Peshawar district, Pakistan. To investigate the queries discussed above, a research questionnaire with a random sample of (n=121) is devised and analysed. Major conclusions drawn from this survey are (1) About (54.5%) of women are aware of energy savings by doing proper management (2) Females are also wise in decision making at households. (3) About (55.3%) of the womens are aware of peak hours unit and (48.4%) of females are aware of hours of electricity and gas load shedding and in lieu of waiting for electricity and gas recovery, women know how to manage routine chores but yet 52.6% gap leaves a pace for policy makers to integrate social and behavioral aspects of energy consumers and move toward energy efficient and sustainable solutions of energy management at residential sector.

***Keywords*—** energy management, residential sector, females, Peshawar.

I. INTRODUCTION

Different energy management practices are being applied in different parts of world. One of the most effective energy management strategies is energy conservation as discussed in most of the literature. 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. According to the recent global gender gap report index, the study shows that less than seven percent of the women are at managerial positions in the four worst performing countries including Pakistan and also the women spend on average twice more time in contrast to men on the household and other unpaid activities [1]. Contrarily the Pakistan across its length and breadth is in complete energy crisis. The full-fledged energy shortage levy discomfort, water and food scarcity, electricity cut off and thousands of jobless people [2]. Currently Pakistan is facing short-fall of power output around 6500 MW except for the nonrenewable energy. Pakistan has renewable energy potential of 2,900,00 MW for solar, 346000 MW for wind 3000MW for biogas, 2000 for small hydropower and 1000MW for waste-to-energy, with its share in total present energy scenario being less than 1% [3]. According to the Pakistan energy year book data (2017) collectively oil and natural gas supply a bulk of 79.2% of Pakistan's energy need. The consumption of these energy sources tremendously cross the indigenous supply. This condition forecasts the dependency on LNG imports which is almost 5.6% making it an import economy which dramatically enhances the country's poor financial conditions. The Pakistan is now in import economy zone with its oil import bill prices are about 9.1 billion dollars as seen in

Figure *1*. Also the developing economies are fuel importing countries, and the process of fuel import is multifold given that transportability of fuel itself requires more fuel which counter attack the environment in one or the other way. At the same time the recent study of gender gap report (2018) reveals the fact that Pakistan is considered to be the worst performing country lying below the global average scale and ranked at 148 with 0.550 score out of (0-1) and in Economic Participation and Opportunity it is ranked at number 146 with score of 0.318 out of (0-1). However, Pakistan is closing the gender gap in the education achievement and wage equality [1]. Considering the aforementioned scenario of Pakistan in regards to severe energy crisis, the energy conservation is one of the most environment friendly solutions for fulfilling the energy crisis of a nation and meets the demand of increasing population. The conservation can be done in different ways but integrating the efforts of women in energy management practices, is not being fully evaluated in developing countries. Also the sector wise energy

consumption levy the fact that domestic sector in Pakistan consumes 22.6% energy as clear from

Figure 2. Thus relating the household sector, energy management and women participation in domestic sector can clarify the picture of behavior of women in regards to her awareness level with energy management. Prior to unfold the findings of this research, it is mandatory to understand the relation between (1) energy, gender and environment, (2) household economics (3) energy consumption at residential sector.

1.1 Interconnectivity of energy, gender and environment

Human activities are not solely for the purpose of living in a society but also to survive in an environment and thus energy enters into a physical and technical society in terms of food and its utilization and ultimately have unforeseen environmental consequences [4]. The typical energy resources human began to utilize were from fossil fuels at an appreciable rate of about 150 years ago [5]. Energy consumption is never ending and unstoppable phenomenon for the human survival and both developed and developing countries are using energy in different forms. One study shows that consumption of energy is not fully understood by the humans [6]. Similarly most of the times it happens that what people say is in converse with what people do in daily life in regards to energy use [7]. Gender, technology and sustainability are all interrelated terms with complex parameters that involve socio-physical, economical, behavorial factors [8]. However, on the other hand the developing and developed countries are concomitantly encountering the inauspicious environmental conditions. In order to enter into the market competitiveness, the developing countries are sparing no effort in order to increase their economic growths which ultimately lead those nations to utilize more energy. Utilizing energy in such a way to make it affordable can help to reduce poverty and enhance economic situation more better [9]. In an effort to enhance the economic growth, the consumption of energy is having adverse effects on environment in form of land derogation, air pollution, resource shear, water shortage, adapted climatic conditions (acid rain, greenhouse gas emissions etc.) and vulnerable wild life. With this, the domestic sector is also accountable for negative environmental effects [10]. For example rural household energy consumption contributes to climate risk conditions due to CO2 emissions because of their use of biogas, wood etc. [11]. Urban household women spend more time in kitchen than rural women [12]. One of the rural household energy consumption study in China shows the interesting findings by relating the household energy usage pattern and lifestyle with the amount of CO2 emitted into the environment by analyzing the real time data. The key findings shows that CO2 emissions increases with (1) the large number of people living in the house (2) where people are more educated, thus acquire to have better life standard and use more energy (3) households where people are getting more income can bear all expenses for leading a comfortable life [11]. Thus the energy has close relation with environment and its effect can be adverse or positive depending upon people's reliability on types of fuels and sources they use for energy utilization either directly like for space heating, cooling and comfort or indirectly like the tools used for mobility or delivery of materials from place to place. The lifestyle of people like the way they eat, live or use vehicles for mobility had its impact on surrounding and is not the only but one of the essential tool to look deep into it for energy saving as well as clean environment practices [10].

1.2 Energy utilization at residential sector

Energy is being utilized at different sectors like industrial, commercial, transport, domestic as seen in

Figure 2 and its consumption cum utilization depends upon the requirement of energy for that locale. Household energy consumption is a complex process driven by various individual and situational foretellers [13]. Residential sector has a major pace in energy utilization because it is the place where human needs are getting fulfilled and without using energy it is not possible to meet the demands of daily life [10].

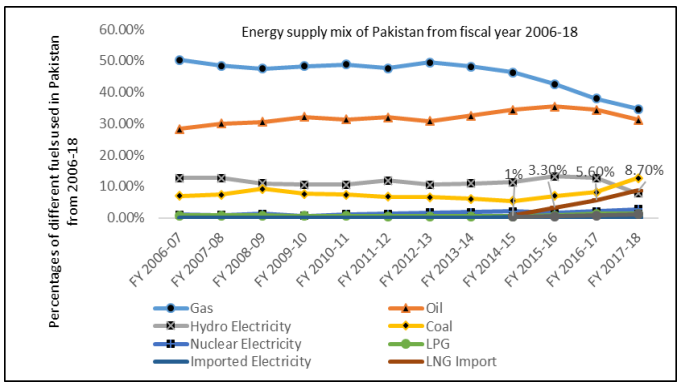

Figure 1 Pakistan's primary energy supply mix for the year 2006-2018 [14]

In a household system the men, women and children all are using energy or energy related technologies like fans, bulbs, refrigerators, washing machine, mobile phones, computers, laptops, microwave oven, air condition, television, iron etc. All these mentioned technologies are basic needs of life and everyone in the house has access to these gadgets according to their needs. For example men mostly use laptops or watch television whilst children may use toys that need charging and women has access to all kitchen related stuff as well as other tools as she is running the household all the day long. Behavioral aspect of personnel consuming energy is key factor in either saving energy or wasting energy by doubling its demand [12]. Water management by female in Tanzania, African country has also undergone through a research study and the case shows that females are recessive as compared to males [15]. The housing lifestyle in European countries exert influence on energy usage [10]. On the other side the physical environment is being affected by the cultural environment which includes all the correlated cultural, technological, behavioral and decision making factors of a cultural society consuming energy [12].

In the developing countries the energy consumption depends directly on increasing level of GDP, urbanization , level of income in contrast to depleting natural resources [16]. For example same level of urbanization in two cities might have different energy consumption which is a proof of other variables such as social, economic, and environmental aspects to be involved in changed energy usage pattern [16]. Viz a viz people with average income, spend more on energy related stuff as compared to the people having high level of income [16].

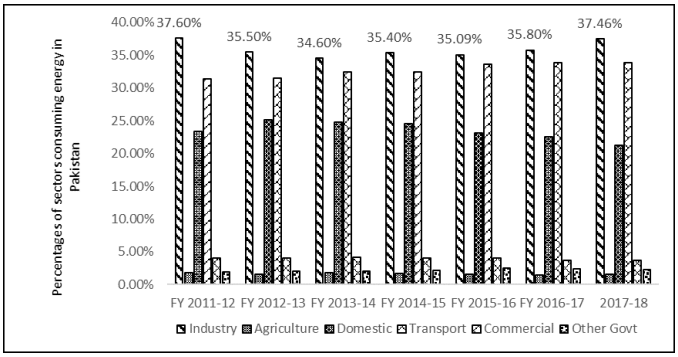

Figure 2 Sector wise energy consumption in Pakistan from year 2016-17 [3]

However, the location of the city does not account as the main perimeter for energy usage except the subtropical regions where the household energy consumption seasonally varies such as regions across Asian, European and American countries but it did not vary in tropical regions [16]. The same results were achieved when the study carried out among ten different European countries-the country of residence did not affect the energy saving efforts carried out daily [10].

1.3 Household economics and energy consumption

Household decision making process is complex and is individual's way of thinking [17]. Energy savings can be achieved by behavioral wise way of thinking [18]. It is an era when one need to move beyond gender differences to think optimistically about the social value of energy [19]. Keeping in mind all the factors related to energy and gender it is obvious that energy is purchased for getting some useful work done within the household, that energy can be in the form of electricity as well as fuel, there are respondents (the people living in a house) to use that energy, a part of that energy is wasted while consuming it, the output of that energy is needs of household are getting fulfilled and that energy also effects the environment. So there is services and good production inside the household by its members and commodities are meals, grocery, power utility and the labor is cooking, cleaning, ironing, and laundry [20]. As another argument 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 [21]. One of the study from Netherlands concluded that demographic and economics are the major constituents of the residential dwellings [22]. Another finding of the Bangladesh studies which measured the household electricity consumption using Multi-Tier framework formula reveals that electricity supply during the peak hours i.e. evening time is mostly subjected to outages [23]. The economy involved in household production is named as Gross Household Production. The unseen and unpaid human labor inside the house hold is basically the human capital and by using this capital the raw form materials or commodities are finalized into the physical forms like food , neat and clean living and others etc. [20]. 60% of GNP is covered with household purchases. According to a household study the effort done to earn money outside of house is less than effort done to satisfy households' tasks and it will surpass with the passage of time. To make women's unseen labor at household notable, the household production measurement is necessary.

1.4 Energy management practices at household level and policy implications

One of the research study in US unveil the fact that highly educates as well as married females cannot pay attention to both their work and household responsibilities [24]. The bulk of energy usage at household level is not ignorable and correlated to per capita energy consumption and Human Develop Indicator [9]. More people living in a house as an obvious discussion consumes more energy but energy used per capita in a house where multiple families are residing the energy is shared [13]. In female-headed houses in the rural areas 1.3 billion women are living in poverty [9]. In Asian countries, the problems related to energy consumption require an in depth study from the ground level to make changes in their policies [16]. Women needs to cope with not only the daily routine chores but also the childrearing and other responsibilities are at her shoulder each day and this burden indirectly matters a lot when it comes to success or failure of any policy. Engaging women from the household sector into the advanced energy management tools with new technology can help policy makers to set new foundations for energy saving techniques and economy enhancement of a nation. A range of multiple parameters can be crafted for creating awareness of energy management through these parameters [12]. According to a research study in United Kingdom the dwelling parameters of household such as size of house, total number of people living in the house, electricity and gas appliances used for space heating and cooling have been covered by many researchers and literatures but the factors related to ownership of appliances used in the household are paid least attention [25]. During the child rearing period in the house the energy use is more dominant as the household activities increased such as washing, cooking, cleaning etc. [13]. The multiple household related parameters and the gender role specially the women participation as described above from different studies through different parts of the world can help the policy makers to make changes or amend the existing policy structure already described for gender role to have a better energy saving methods. Most of the times females might be the victim of the poverty and thus they need different energy policy [9]. For instance 2.5 billion people use biomass fuels in developing nations and 1.6 billion people are without electricity due to non-availability and affordability [9]. Another study concluded that the residential sector is the primary area to target for energy management measures [25]. In a challenging era where the world is moving towards the energy deprivation the technical solutions are not enough to get rid of the underlying problems. The social value of energy and human behavior towards this, needs an in depth study and understanding. Therefore, the researchers and policy makers ought to integrate social and behavioral aspects of energy consumers and move toward energy efficient and sustainable solutions of energy management [13]. Awareness to home owned technologies for the home dwellers place an important role in analyzing energy conservation of household [13]. Invisible factors such as government policies for the environment and public,

infrastructure, role of media and others may participate to encourage household owners to opt for energy conservation tools while utilizing energy [13].

II. METHODOLOGY

2.1 Demographics of Khyber Pakhtunkhwa

Khyber Pakhtunkhwa formerly known as North West Frontier Province (N.W.F.P) shares its borders with other provinces of Pakistan to its south-east lies the Punjab , to its south-west lies the Baluchistan, to the west and north it shares a border with Afghanistan and to the east and northern areas it has the Azad Kashmir and Northern areas (Retrieved from: http://kp.gov.pk/).

2.2 Population overview of Khyber Pakhtunkhwa

With a population of 30,523,371 in Khyber Pakhtunkhwa it is divided further into hierarchy of Divisions, Tehsils, and Districts. The seven divisions of the Khyber Pakhtunkhwa are Malakand ,Hazara , Mardan, Peshawar, Kohat , Bannu and D.I Khan.

Figure *3* indicates that the Peshawar division has the population of 7,403,817 which is 24 percent of the entire population of KP province and is the second large division after Malakand division which is 25 percent. Our area of conducting research is Peshawar District-Tehsil that has the population of 4,269,079 (58%) [26]. Pakistan's sixth populated city is Peshawar with an area of 1257 kilo meter square. The counted number of the males in Peshawar is 2,201,257, and the females are 2,067,591 and average annual growth rate is 3.99% from 1998 to 2017 (Retrieved from: http://www.pakinformation.com/population/peshawar.html). This is an overview of population statics for the Peshawar city. The next section deals with the climate and weather of KP.

2.3 Climate and weather of Khyber Pakhtunkhwa

Khyber Pakhtunkhwa experiences four variety of seasons with most prominent are summer months start from May to September when an average weather approximately reaches to 40°C (104°F) and the winter month takes start from November and stay till February with average minimum temperature recorded as 4°C (39°F) (https://en.wikipedia.org/wiki/Climate_of_Peshawar). Speaking about the rainfall pattern in Peshawar, it comes under the Zone 2 area and has both hot and cold climate located in between 31 degree N to 34 degree N [27]. Conversely, hourly weather data can be obtained from Pakistan Meteorological Department which is the official website for getting weather updates (Retrieved from: http://www.pmd.gov.pk/).

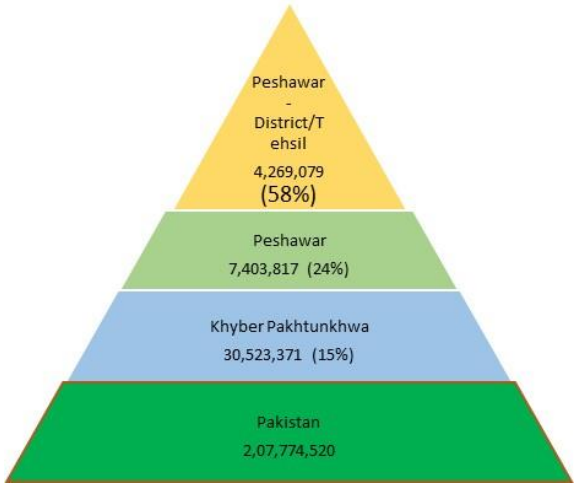

Figure 3 Pyramid showing the population of Pakistan from province level to tehsil level [26]

2.4 Questionnaire distribution and collection criteria

With an aim of procuring data of household women involvement in energy management practices, this research study was conducted in (2019) in Peshawar district. The survey query is randomly distributed by hands across the different areas of Peshawar and respondents were given a time of a week to respond and remit it back. The random selection criteria is adopted from similar research study carried out in Indonesia. 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 10% of error tolerance the expected sample size of questionnaire came out to be 125 and by this calculation a total of 200 questionnaire were distributed and about 121 responses were received. Table 1 indicates the details of the survey questions.

TABLE 1 DETAILS OF QUERY INVESTIGATED REGARDING ENERGY MANAGEMENT

S.No.	Question Investigated
1	Demographics of the respondents
2	Awareness level of respondents about energy management
3	Information about peak hours' unit
4	Awareness of advantage of using renewable energy resources
5	Specification of any renewable energy resource currently in use
6	Idea of energy consumption of electrical appliances
7	Idea of electricity load shedding pattern
8	Idea about the hours' of load shedding
9	Alternate source use in case of electricity load shedding
10	Time management criteria Vs routine chores
11	Idea about gas load shedding pattern
12	Idea about hours' of gas load shedding
13	Kitchen management criteria during gas load shedding
14	Awareness about high billing cost during peak hours
15	Awareness about energy saving initiatives
16	Participation interest in TV ads relating the energy management
17	Information about living room occupancy during night time
18	Information about responsibility to turn of fans and lights

2.5 Eliminating mischievous responses

In order to get stable and reliable results the survey questionnaire should be free from the different types of respondents like outliers, mischievous respondents, fake respondents etc. Either it is a paid survey questionnaire or unpaid there is always probability of having mischievous responses. To get the most accurate results and valid data an algorithm named as the distribution-free, sample-size- unconstrained, backward-stepping MR is applied here and two respondents were found to be mischevious [28]. For the data analysis and applied algorithm SPSS software and microsoft excel were used [10, 28, 29].

III. RESULTS AND DISCUSSIONS

The queries of this research deals with awareness level of respondents towards energy management. The scope of our research is Peshawar district mainly and targeted respondents are females which are mostly marginalized in society due to cultural, religious, social and other involving factors. To get an idea of female's interest level towards energy management a total of (18) questions are cross-examined. From Figure 4 it is deducted that average number of females are aware of the household energy management. 50% of the females wait for recovery of light to cover routine chores and about 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.

Figure 5 and Figure 6 enounces the fact 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 results of closed ended questions are tabulated in Table 2, Table 3 and Table 4.

Fifty five percent of the females are aware of the peak hours' unit. 51% 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, collectively these figures are clear indication of women role in the household energy management and the way she responds to energy changes as a result of blackout hours.

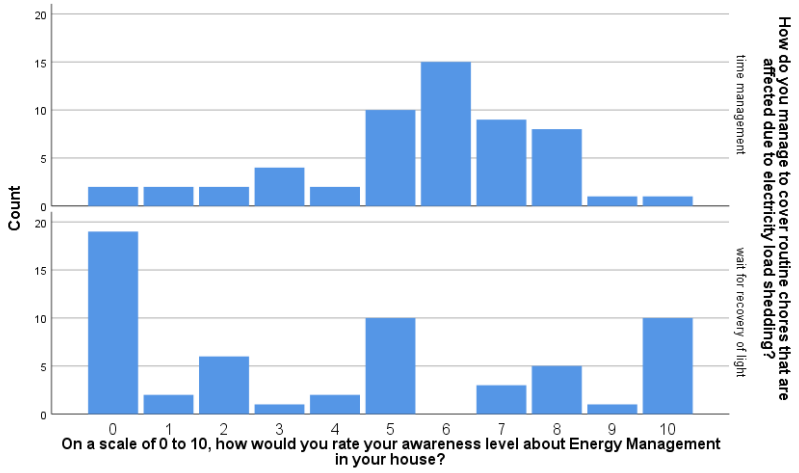

Figure 4. Comparison of awareness to energy management Vs. management of routine chores.

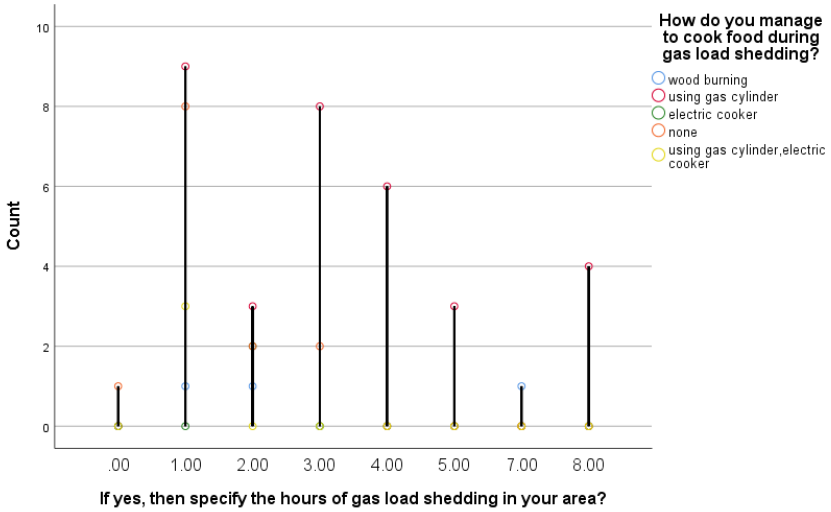

Figure 5. Hours of gas load shedding vs. alternate source used during load shedding

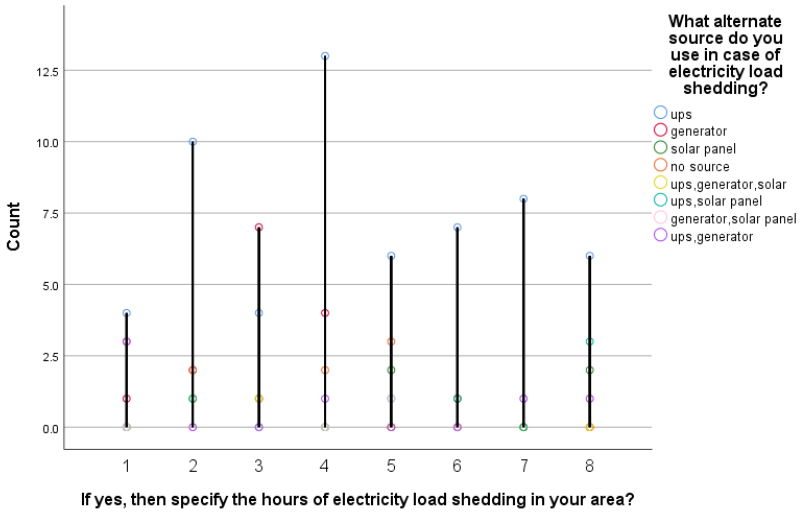

Figure 6. Hours of load electricity shedding vs. alternate source used during load shedding

TABLE 2 INFORMATION ABOUT PEAK HOUR'S UNIT

Do you know about the peak hour's unit?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	68	55.3	55.3	56.8
	no	51	44.7	44.7	100.0
	Total	119	100.0	100.0	

TABLE 3 STATICS FOR THE AWARENESS OF HIGH BILLING COST PER UNIT OF ELECTRICITY

Are you aware of high billing cost per unit of electricity during the peak hours?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	65	51.5	50.4	50.4
	no	54	48.5	49.6	100.0
	Total	119	97.7	100.0	
Total		119	100.0		

These results are also an indication of women working hours in the household with the elecricty and gas related chores, which indicates an indirect relation of females with the energy utilization and that is ultimately adding up into the economy of a nation.

TABLE 4 RESPONDENTS INFORMATION ABOUT ENERGY SAVINGS

Are you aware of energy saving information provided at the backside of utility bills?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	72	54.5	55.8	55.8
	no	47	45.5	44.2	100.0
	Total	119	97.7	100.0	
Total		119	100.0		

CONCLUSION

Conclusions drawn from this survey research are women are aware of energy savings by doing proper management and wise decision making at households. This result is in line with a study that has already proved that the behavior of a person widely effects the household energy consumption [30]. Females are aware of hours of electricity and gas load shedding in their area so instead of waiting for electricity and gas recovery, women know how to manage routine chores. Women in the households also bear an idea of renewable energy resources but they are slowly moving towards renewables. Another positive indication by this research is that the females are aware of electricity consumption during the peak hours but an unexpected response against the same questions appears that 51.5% of the respondents know the high billing cost of electricity while 48.5% respondents denied to know the information about high billing cost. Again this 48.5% denial reveals the fact of keeping very low awareness of energy management at household level.

FUTURE WORK AND POLICY IMPLICATIONS

Before acquainting the policy suggestions, it is noticeable to know the limitations of this study. This sole study does not completely identify all the parameters which are accountable in energy management of household system. The religious norms are unquestionably the same for Muslims but demographics, psychographics and sociographic of Peshawar 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. Researchers are motivated to further dig deep into the gender, environment and energy nexus study within the other province of Pakistan and compare the results to come up with specified methodology and framework to evaluate the energy management practices at domestic sector. To find the missing links in the literature in between developing as well as developed nation relating gender, energy and environment studies.

This study has demonstrated very clearly that women's role in household energy management is remarkable and her efforts are uncountable. She is knowledgeable and it is necessary to integrate women's knowledge, skills, efforts and hard work into the society either explicitly-by doing job or implicitly- by better household management. Policy makers should not ignore the women's participation into the society as an essential tool for a successful developed nation by keeping in view the social, cultural and religious background of a homogenous society and this participation is not ignorable [29]. Policy makers are requested to raise the gender disparity issue on a forum and encourage women to participate in energy management schemes and educate women about the most updated and current technologies and their effective use which indirectly relates the energy use and energy saving. Researchers are encouraged to manipulate the gender inequality in society, energy consumption behavior and gender response to this behavior and household economy with different angles. For developing nations like Pakistan, it is necessary to conduct such research and make the women's participation as the strongest tool for the success of nation. In a challenging era where the world is moving towards the energy deprivation, the technical solutions are not enough to get rid of the underlying problems. The social value of energy and human behavior, needs an in depth study and understanding. Therefore, the researchers and policy makers ought to integrate social and behavioral aspects of energy consumers and move toward energy efficient and sustainable solutions of energy management.

AUTHOR CONTRIBUTIONS: Conceptualization: N.W.Q. and Z.R.A.; methodology: N.W.Q and Z.R.A.; software: N.W.Q. S.W.Q.; validation: N.W.Q. and Z.R.A.; formal analysis: N.W.Q. and S.W.Q.; writing—original draft preparation: N.W.Q. and S.W.Q.; supervision: Z.R.A.; project administration: Z.R.A.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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