Household Energy Poverty in Pakistan

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ABSTRACT

This research study examines the impact of electricity sector reforms on the household welfare of the country. The ongoing reform process gradually eases the fiscal burden by eliminating subsidies. However, an increase in electricity prices reduces poor households' affordability and is thus believed to increase energy poverty in Pakistan.

This study found that increasing electricity prices burdened the limited household resources and thus altered their budgetary allocation by employing secondary data. Further, it is found that without undertaking appropriate measures of compensation, a substantial proportion of poor households would be dragged below the poverty line. The study suggests that successful reforms should be accompanied by compensation packages for the poor and increased service quality and reliability for households paying higher prices.

The study also conducted a household survey of Karachi city as a case study to obtain in-depth information on the energy situation. Findings from the survey data show that although tariff rates are still subsidized for lower consumption households, additional charges like government charges, TVL fees, fuel adjustment charges etc., constitute a significant proportion of total electricity bills. The study also recognizes households' cognitive and behavioural aspects in energy use by incorporating these modules in the survey questionnaire. Hence, numerous viable policy options are recommended in the study to successfully implement reforms without compromising the social aspects.

PREFACE

The Government of Pakistan has initiated electricity tariff reforms that directly impact the household welfare of the country. As a result of these reforms, the government has started curtailing the electricity subsidies, gradually increasing end-consumer electricity prices. However, changing the policy to raise the subsidized electricity tariff decreases the affordability of a consumer and impacts the overall welfare of a household, thus believed to increase the energy poverty in Pakistan.

This research study is written by a team of researchers within the Applied Economics Research Centre, University of Karachi. The core team consisted of Dr. Fouzia Sohail (Team Leader and Assistant Professor), Dr. Ambreen Fatima (Co-PI and Associate Professor) and Ms. Javeria Ahmed (Research scholar and M.Phil student). Household data was collected by trained M.Phil and Ph. D. students of AERC, under the supervision of Dr. Faizan Iftikhar (Assistant Professor), Mr. Sohail Javed (Assistant Professor) and Mr. Aleem Qureshi (Ph.D. Student). Ms. Lubna Naz (Staff Economist) analyze the primary household data conducted in the research. She enthusiastically assist PI and Co-PI in overall completion of the project. Ms. Munazah Nazeer (Ph.D. Student) analyze the impact of tariff increase by using HIES dataset. Ms. Javeria Ahmed provided her support in data cleaning, editing and coding. Without dedication and team effort, the completion of the project would be impossible.

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INTRODUCTION

It has been evident that despite several reforms, the power sector of Pakistan has been plagued with inefficiencies, including low collections, theft, transmission and distribution losses of around 20%, delays in determination and notifications, increased cost of fuel imports, rupee depreciation etc. It is found that the cost of generation had a high correlation with oil prices in Pakistan till 2013. After 2013, electricity generation moved from oil-based plants to more RLNG plants, but the generation cost is still increasing because of rupee depreciation. In Pakistan, the cost of generation is 9.2 cents per kWh compared to 5.5, 6.8, 3.0 cents per kWh in India, Bangladesh, and Nepal, respectively. All these inefficiencies contribute to an increasingly severe circular debt problem. Recently, Pakistan has had a circular debt of 2.4 trillion rupees.

To undertake these challenges, the Government of Pakistan has initiated significant energy sector reforms, including tariff reform, that directly impact the household welfare of the country. As a result of these reforms, the government has started curtailing the electricity subsidies, gradually increasing end-consumer electricity prices. However, changing the policy to raise the subsidized electricity tariff is not easy. An increase in tariff decreases the affordability of a consumer and impacts the overall welfare of a household. The study of Makmun & Abdurrahman (2003) shows that an increase in basic electricity tariffs has a negative impact on the real income of the community. The decline in real public realization causes the purchasing power of the people to decline. The decrease in purchasing power that is not accompanied by income improvements potentially increases the number of poor households (Ikhsan & Purbasari 2012). Recent tariff reforms thus have a profound economic and social impact, especially on poor households. It has been argued that not all households respond similarly to tariff reforms. Households with relatively low price elasticity of electricity demand, predominantly with higher electricity consumption, are less likely to change their electricity consumption in response to an increase in electricity tariff, but this will increase government revenues (Moshiri, 2015). However, households with small electricity consumption generally have relatively inelastic demand; thus, welfare decline is expected to be hugely related to tariff increase (Lampietti J., World Bank., 2004)

Another critical policy dimension that needs to be addressed is access to more efficient and clean energy sources. According to the World Energy Outlook (2016) statistics, at least 51 million people in Pakistan, representing 27% of the population, live without access to electricity. In its annual State of the Industry Report, the National Electric Power Regulatory Authority concludes that approximately 20% of all villages (32,889 out of 161,969) are not connected to the grid. Even those households that are statistically connected daily experience blackouts, so it is estimated that more than 144 million people across the country do not have reliable access to electricity. A survey revealed that rural households in Punjab spent about 9 % of the total household income on fuel and lighting. However, poor households are forced to invest up to 25% of their monthly income in fuel, kerosene and batteries due to the dysfunctional market.

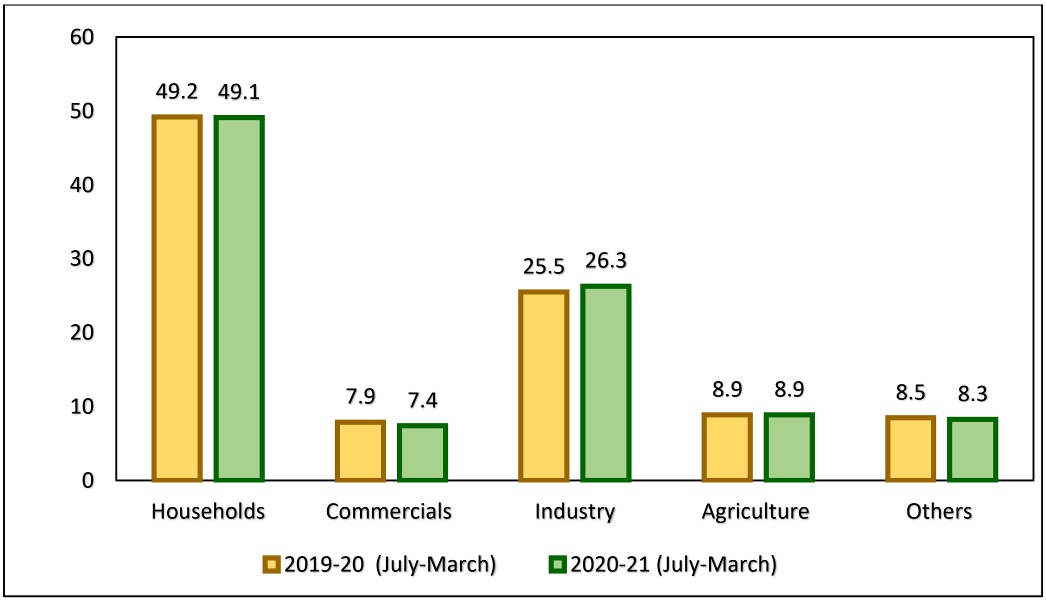
These sporadic findings from various sources reveal the power sector distortions and their impact on household welfare and poverty in Pakistan. However, the research activity on energy poverty in Pakistan is very limited. Notably, the welfare impact of the recent upsurge of electricity tariffs due to the gradual elimination of subsidies has not yet been gauged in any study. This study thus aims to analyze the impact of subsidized tariff changes of electricity on the welfare of households. More specifically, the present study attempts to find the crowding-out effect of increased electricity tariff on household budgetary allocation of resources at various income levels. It is suggested that an increase in tariff worsen individuals by reducing the income left for spending on other consumption goods and services. Hence, the study also aims to measure the compensation required by the households to mitigate the income effect of rising electricity tariffs on households' welfare. We thus also endeavour to estimate the proportion of households dragged below the poverty line if these poor households are not compensated. However, because of the existing caveats in the secondary datasets, the study aims to conduct a primary survey of Karachi city as a case study to obtain in-depth information on the energy situation. A primary survey regarding households' energy affordability and accessibility along with socio-economic conditions of a household is the need of an hour for conducting the in-depth analysis of rising electricity tariff on poverty. Keeping all these data caveats and limitations, the current study also conducts an in-depth survey of electricity consumers as a case study in Karachi city.

This research paper is thus organized as follows. The following section traces the progression of electricity tariff over the last few years. This section provides us with in-depth information on the breakup of various slabs and the change in applied tariff rates over these slabs. Section 3 presents the review of the literature. This section helps us identify the research gap on the issue. Section 4 presents a detailed methodology applied in econometric estimations of the above-defined objectives. In contrast, section 5 of the research paper provides results, analysis, and thorough discussion, which further support public policy provision in this research area. Last section concludes the study and discusses the viable policy options.

1.1 Background on Energy Tariff Reforms in Pakistan in Context of Household Welfare

According to the recent statistics of electricity consumption provided by Economic survey (2020-21) (reproduced in figure 1), residential sector is the major consumer of electricity (49.1%) followed by industrial sector (26.3%). According to World Bank (2014), about half of subsidies in 2012-13 were enjoyed by residential sector, one quarter by manufacturing and industrial sector and remaining by other sectors. These statistics show that residential sector consume substantial percentage of total electricity consumption thus tariff reforms would have profound impact on the wellbeing of domestic households. Hence in this section, we present the evolution of tariff slabs, per unit change in electricity price for each slab and structural modification for residential sector over the recent years.

Figure 1: Share of Electricity Consumption by Sector



Source: Economic Survey (2020-21)

Table 1 shows the tariff structure for electricity consumption, which is based on standard slabs of monthly consumption as defined by the government for all distribution companies (DISCOs and K-electric). These slab wise charges are usually termed as the tariff structure for electricity consumption.

Table 1: Slab Structure for Electricity Consumption for Household

S. No.	**Before Sep. 2008**		**After Sep. 2008**		**S. No.**	**Since 2014**	
	Standard Slabs (units)	**Units/ Slab**	**Standard Slabs (units)**	**Units/ Slab**		**Standard Slabs**	**Units/ Slab**
0	≤ 50	50	≤ 50	50	0	≤ 50	50
For consumption exceeding 50 units							
1	1 - 100	100	1 - 100	100	1	1 - 100	100
2	101 - 300	200	101 - 300	200	2	101 - 200	100
3	301 - 1000	700	301 - 700	400	3	201 – 300	100
4	≥ 1000		≥ 700		4	301 - 700	400
					5	≥ 700	
Total units beyond the highest rate		**1000**		**700**			**700**

Source: Authors' tabulation, Ministry of Energy, Pakistan

Table 1 shows the slab structure before and after September 2008. Prior to September 2008, the highest standard slab was charged beyond 1000 units, while after September 2008, highest price slab was applied if the units consumed were increased beyond 700 units. Hence, the limit beyond which highest tariff is to be paid was reduced by 300 units. However, this structural change in tariff slab was believed to affect the affluent the most.

Then in 2014, the second slab was split into two with 100 units in each slab. Thus the households had to pay higher tariff than before on consumption of 201 to 300 units. Through these reforms, government aimed to reduce subsidies by increasing per unit cost of electricity at middle slab, thus believed to target the middle income households.

Another significant structural modification was undertaken by the NEPRA in 2013-14, according to which, "all-slab benefit" was replaced by "previous-slab benefit" policy. Under this new policy of previous-slab benefit, only two rates are then applied to each household. This was an important policy shift, undertaken by the Government, to limit the affluent class accessing the more subsidized rates of lower slabs.

Table 2: Tariff Structure for Residential Electricity Consumption

Unit Slabs (units)	2022	2021	2020	2019	2018	2014	2012	2011	2009	2008
w.e.f.	Dec 2021	Jan 2021	May 2019	Jan-2019	Jun 2015	Oct 2014	May 2012	Mar 2011	Dec 2009	Sep 2008
For Sanctioned Load up to 5KW										
≤ 50	3.95	3.95	3.95	2	2	2	2	1.87	1.48	1.4
For consumption exceeding 50 units										
1 - 100	9.35	7.74	7.74	5.79	5.79	5.79	5.79	4.45	3.49	3.23
101 - 200	11.67	10.06	10.06	8.11	8.11	8.11	8.11	6.73	5.26	4.9
201 - 300	13.76	12.15	12.15	10.2	10.2	12.09	8.11	6.73	5.26	4.9
301 - 700	22.88	19.55	21.2	19.25	16	15	12.33	10.65	8.51	7.97
≥ 700	25.98	22.65	24.3	22.35	18	17.5	15.07	13.29	10.6	10
For Sanctioned Load exceeding 5KW										
Peak	25.98	22.65	24.3	22.35	18	17.5	13.99	12.25	9.76	9.15
Off Peak	19.66	16.33	17.98	16.03	12.5	11.5	8.22	6.7	5.96	5.56

Source: Authors' tabulation using K-electric and Economic survey data

Table 2 shows that the applicable tariff is frequently increasing from 2012 to 2021 for all consumption slabs except for the lowest three slabs, that is, slabs of ≤ 50, 1-100 and 101-200 units. This shows that tariff rates are increasing with increase in consumption of electricity units. This implies that comparatively lower tariffs are charged from consumers in the lower slabs as lower slab consumers usually belong to lower-income households. Higher income households are believed to occupy larger housing areas with multi floor dwellings, hence, use more electrical appliances that would increase household power consumption.

Table 3: Percentage Increase in Tariff Structure for Residential Electricity Consumption over Time

Unit Slabs (units)	2019 &2021	2018 &2019	2014 &2018	2012 & 2014	2011 &2012	2009 & 2011	2008 & 2009	2008 & 2021
For Sanctioned Load up to 5KW								
≤ 50	97.50	0.00	0.00	0.00	6.95	26.35	5.71	**182.14**
For consumption exceeding 50 units								
1 - 100	33.68	0.00	0.00	0.00	30.11	27.51	8.05	**139.63**
101 - 200	24.04	0.00	0.00	0.00	20.51	27.95	7.35	**105.31**
201 - 300	19.12	0.00	-15.63	49.08	20.51	27.95	7.35	**147.96**
301 - 700	10.13	20.31	6.67	21.65	15.77	25.15	6.78	**166'00**
≥ 700	8.72	24.17	2.86	16.12	13.39	25.38	6.00	**143.00**
For Sanctioned Load exceeding 5KW								
Peak	8.72	24.17	2.86	25.09	14.20	25.51	6.67	**165.57**
Off Peak	12.16	28.24	8.70	39.90	22.69	12.42	7.19	**223.38**

Source: Authors' tabulation using K-electric and Economic survey data

Table 3 reveals that the highest growth of 97 % is recorded between 2019 and 2021, for the lowest slab, which is considered as lifeline tariff slab. Similarly, from 2008 to 2021, the highest increase in tariff rate (182 %) is recorded for the lifeline slab, which is a matter of concern. This increase in tariff is believed to hurt the poorest as life line tariff is envisioned to safeguard the poor. This policy shift, if not accompanied with compensatory measures, may dragged the certain proportion of population below the poverty line. It has been argued in the literature that although the consumption of electricity is lower for lower tier income group but increase in electricity prices would have relatively higher impact on their wellbeing (World Bank, 2017).

The last two rows of table 3 shows tariff increase for households having sanctioned load greater than 5 KW and a special time-of-use (ToU) meter. For such consumers, ToU tariff rates are applied. The off peak rates that constitutes most of the daily hours grew by 223.38 % in thirteen years period, while during the peak hours, the highest rates are charged, irrespective of total number of units consumed.

REVIEW LITERATURE

Energy subsidies, particularly electricity subsidies, have been the focus of research in various policy institutions like IMF and World Bank as well as in academia. Although, the timeline of policy shift, concerns and welfare impact may vary from one country to another, however, foremost aim is to reduce electricity consumption (or move towards efficient consumption), reduce government expenditure and increase overall wellbeing of poor through income redistribution (Granado et al., 2012). Hence in this section, summary of valuable international and national research on the issue are presented thus to determine, firstly, the outcome of this policy shifts on various economies. Secondly, literature on Pakistan's economy, till date, is reviewed, not only to determine the policy objectives of the electricity price reforms in Pakistan but to find the research gap as well.

2.1 International Scenario

Like many other transition economies, Poland is one that put substantial efforts in bringing the energy prices towards the most efficient levels. Freund & Wallich, World Bank (1995), describes the new pricing system for residential electricity consumption, which was introduced in Poland in early 1990's. As a result of four years of reforms, electricity price for residential sector increased more than three times. Because of the regressive nature of electricity subsidies, Freund & Wallich, World Bank (1995), suggested to increase electricity tariff, accompanied with public support program for poor, including cash transfers, discount vouchers etc, as well as, lifeline electricity block/ slab. The study, however, preferred lifeline pricing on in-kind transfers as the implementation of later is difficult to administer.

Lampietti J., World Bank (2004) investigated the impact of electricity price reforms in Eastern European and Central Asia, which had been initiated in early 90's. Reforms in these countries were based on the advice of World Bank and other donor agencies. Main feature of electricity sector reform was complete removal of subsidies through increase in tariff to full recovery of cost. Donor agencies supported and funded these countries in implementation of reforms, energy efficiency, targeting of poor households for compensation. Countries that have been selected in this study for analyzing the reform's after-effects, included Hungary and Poland that bring reforms more aggressively, while others like Armenia, Azerbaijan, Georgia, Kazakhstan and Moldova. In the study, author concluded from the experience of these countries that tariff increase should be accompanied with enhanced quality of service thus for better general public acceptance of reforms as well as to minimize the negative effects on well-being. It had been noticed that the expenditure share on electricity increased in all of these countries and for each income quintiles, depending on the increase in tariff, inelasticity of demand etc. Poor segment of the society experienced relatively greater welfare loss, thus started searching for other substitutes in response to tariff rise. The study mentioned various indictors to measure the welfare loss. These are, budgetary share of electricity expenditure, which shows the households' total requirement of electricity, their access to low priced substitutes, change in tariff and price elasticity of demand for electricity. Results of the study revealed the highest welfare loss in Armenia and Georgia because of greater increase in tariff and relatively higher dependence on electricity for heating, lightening and cooking. The study suggested the important role of government in mitigating the negative welfare impact of tariff increase, particularly on poor segment.

Unlike the above transition economies that proved relatively successful implementation of reform process, IMF (2013) is found skeptical about the success of energy price reforms in many developing countries. However, Moshiri (2015) exemplify the Iranian energy price reforms as a guideline to other nations, who are in the process of undertaking these reforms. This study mentioned the successful implementation of societal recognition of energy price reforms as these were accompanied with cash handout packages by the Government. Study also mentioned the mixed responses by various societal groups in response to price change. For instance, households with high energy consumption and low price elasticity of demand do not reduce their consumption in response to price change. In this case, government revenues will increase as a result of policy shift but consumption of electricity will not reduce. The results of the study thus show that government of Iran successfully achieved the objective of easing the fiscal pressure through these reforms, however, for achieving the efficient consumption objective, other measures should also be accompanied with subsidy removals.

Unlike Iran, Jordanian economy is in the process of reform and initiated the gradual removal of subsidies from various energy sector, including the electricity sector, only few years later. Atamanov A. et al. (2015), study the impact of electricity price reforms on wellbeing of Jordanian population. Like many other developing countries, including Pakistan, initiation and implementation of reform process in Jordan was not an easy task, especially in the presence of political and economic unrest. However, as this reform process became imperative, Atamanov A. et al. (2015) suggest that flat increment in electricity tariff would decrease the welfare of poorest households. The study, thus, suggests the progressive increments in prices along with compensatory mechanism for protecting the poorest segment of the Jordanian society as well as for successful implementation of the reforms.

Enormous international literature on several countries is available and worth reviewing, however, conclusion is almost similar[1]. It has been concluded that reform process of energy sector, including the electricity sector, have been initiated in countries on advice of international donor agencies for reducing the fiscal pressure by gradual elimination of subsidies provided to all sectors, including the residential sector. Besides, reform process is believed to reduce inefficiencies in electricity consumption that has increased the consumption of electricity, mostly by higher income groups. As residential sector is the leading consumer of electricity, researchers are more concerned and skeptical on the welfare impact of these reforms. Implementation of electricity tariff reforms are believed to depend on politico-economic as well as social acceptance of reforms. Experience of above countries, thus, provide guidelines for developing countries, like Pakistan.

2.2 Literature on Pakistan

With the onset of 1990's power sector restructuring and reform mechanism was initiated in Pakistan but with very slow pace primarily because of unstable political situation of the country. There was also great resistance from general public to any rise in electricity tariff at that time. However, Pakistan has practically initiated the tariff reform process more than a decade ago but again the pace of reform was sluggish until at least 2013. According to WB (2017), electricity subsidies on residential sector has been reduced to about 0.4 percent of GDP from 2013 to 2016. Like many other developing economies, national literature on the issue, expressed skepticism

[1] Nguyen, q. K. (2021), IMF (2013), Clements et al. 2014)

regarding the wellbeing of society from increased electricity tariff. Although, one of the objectives mentioned in National power policy (2013), was to safeguard the poor households from tariff reforms through various compensatory and redress mechanism, on one hand, while, generating sense of responsibility among consumers and to ensure efficient utilization of electricity, on the other.

Considering the above National power policy objective, WB (2017) through a qualitative survey of families from Khyber Pakhtunkhwa (KPK), Punjab and Sindh provinces found the affordability issues for paying electricity bills, among households, despite the fact that reform process was not on full swing at the time of interview. Recipients of Benazir Income Support Program (BISP) also complaint for higher electricity bill. The study thus revealed the insufficient compensatory efforts, so far, by the government. Besides affordability, unreliability of electricity service is another major problem faced by the households. The study revealed lack of confidence and trust of general public on Disco's and K-electric. However, the study suggested further reforms in the sector. The author is of the view that subsidy elimination from this sector would further ease the fiscal pressure and bring sustainability, while fiscal resources would be used for eliminating the negative effects arose from tariff reforms through more spending on social assistance programs and other compensatory mechanisms for poor.

Walker T. et al., (2014), a policy paper published by World Bank, also considered the impact of electricity tariff reforms on welfare, while demonstrates how to continue subsidy elimination reforms in Pakistan. This study simulate the welfare impact on the basis of 2014-15 budget forecast for electricity subsidies with the assumption of sufficient increase in electricity prices to achieve the government's subsidy target and with no compensatory measures taken. With these assumptions, the study found that 97 percent of electricity consumers, except for lifeline users, would face rise in electricity expenditure. However lifeline users and nonusers would also face relatively small welfare loss indirectly. The study estimated only 1.7 percent welfare loss for poor households, while richer households would face greater welfare loss. The study proposed various compensatory options to the government to mitigate the negative impact of policy reforms. These included, amendments to BISP, targeted cash payments to poor households on the basis of poverty scores etc., along with improving efficiency in electricity usage, production and distribution.

Zhang, Fan. (2019), another study of the World Bank, assessed the welfare impact of tariff reforms and estimated the economic cost of distortion for three main South Asian economies, included, India, Bangladesh and Pakistan. The study considered economic losses from subsidy elimination more distortionary than the fiscal losses in the presence of subsidies. For Pakistan, estimated economic cost due to energy sector distortions were 6.53 percentage of GDP in 2015, of which 4.75 percent of GDP is because of the unreliable access to electricity. While the estimated fiscal cost, due to electricity subsidies, were 0.80 percentage of GDP.

It has been noticed that scarce economic literature exist for Pakistan from welfare or poverty perspectives. However, the importance of the topic can be realized by the characterization of losses mentioned by Joskow, (2008). According to Joskow (2008), lack of efficiency in production and distribution, poor or unreliable services, social and environmental loss etc. are all first order effects, while, price distortions are second order losses. It is a matter of fact that Pakistan is currently facing both, first as well as second order effects or losses in the electricity sector. It has been noticed that government electricity policy seems more inclined towards correcting second order distortions, hence, it is recommended that at least similar attention should also be given for fixing the first order distortions in the power sector.

METHODOLOGY

3.1 Crowding out Effect of Electricity Expenditure and Its Implications on Household Resource Allocation in Pakistan

The first specific objective of the study is to estimate the crowding-out effect of increased electricity expenditure and its impact on intra-household resource allocation through the estimation of the conditional demand function. More specifically, we endeavor to analyze the difference in the affordability of electricity between the periods of low and high tariff rates. For achieving these objectives, we employ HIES 2013-14 and 2018-19, assuming the fact that electricity tariffs are relatively low in 2013-14 as compared to 2018-19. Where, HIES 2018-19 is the latest survey at the time of study.

For explaining the crowding out effect of electricity expenditure and its impact on intra household resource allocation, conditional demand function, as suggested by Pollak (1969), is estimated. In the context of current study, crowding out effect of electricity expenditure entails reduced consumption of goods and services because of increasing cost of electricity consumption. The conceptual framework of this paper followed the most recent generation of empirical studies on the crowding-out impact of commodity expenditure (John, 2008; John et al 2012; Hussain et al. 2018; etc).

3.2 Conceptual Framework

Households report zero electricity expenditures either because households do not have access to grid electricity, even if they have adequate income; or households cannot afford electricity expenditure, given their income. For this analysis, households using grid electricity are employed while households do not have grid electricity connections are excluded from the sample.

The study assume that households faces lower tariff rates and thus lower expenditures in 2013-14 compared to significant increase in tariff and thus the higher electricity expenditures in 2018-19. This implies that there is a difference in the spending patterns of households between the two periods. The crowding-out attribution of electricity expenditure in displacing expenditure on other commodities comes with the assumption that a household that spends on electricity decides on paying the electricity bills before deciding on the quantities of the other goods and services. Given this, household's demand for a particular commodity is conditional on the household's electricity expenditures and the remainder of household income after paying electricity bills. Following the recent literature, we estimated and compared a set of Engel curves for electricity expenditure during low tariff rates with conditional Engel curves for electricity expenditure during high tariff rates for a common set of commodities. If, on average, the quantity demanded of a commodity for the typical household in 2013-14 is less (more) than the quantity demanded of the same commodity for a typical household in 2018-19, then the difference can be attributed, ceteris paribus, to increase in electricity tariff during this period.

For estimation purposes, let us assume that households have already decided its budget on electricity consumption and a certain amount is been pre-allocated for it. This effectively means that the household now has to maximize its utility subject to the expenditure in excess of the pre-allocated expenditure for electricity. If electricity is the n^{th} good, we assume that first $n-1$ goods are available in the market for the prices $\{p_1, ..., p_{n-1}\}$ over which the household has no control and the total expenditure on these goods are given by M ($M = Y - P_eE$), where P_e is the price of electricity and E is the quantity consumed).

3.3 Empirical Technique: Quadratic Almost Ideal Demand System (QUAIDS)

In the first stage of our empirical approach, we compared the mean expenditure shares for the food and various non-food expenditure categories between the two time periods, using the t-test on the equality of means. Statistically significant differences in the expenditure dedicated to other commodities in the budgets of households between 2013-14 and 2018-19, indicate unadjusted difference in budget share between the two periods. However, these unadjusted differences in expenditure shares do not take into account households' socioeconomic, housing and demographic characteristics that may have influence on spending pattern. Therefore, we formally tested the crowding-out hypothesis using multivariate regression analysis, controlling for household-specific characteristics. To determine differences in spending patterns of households between the two periods, the regression models estimated conditional Engel curves for 11 expenditure categories using the Quadratic Almost Ideal Demand System (QUAIDS) developed by Banks, Blundell, & Lewbel (1997).

Several studies on the crowding-out effect emphasized the potential endogeneity of total expenditure and expenditure on pre-determined commodity (electricity expenditure in this case) and therefore used the instrumental variable (IV) method to obtain consistent and unbiased -estimators. In this study, we instrumented household total expenditure by total income and total number of assets of a household. Electricity expenditure are instrumented by electrical equipment owned by a household.

If household expenditure in one category is correlated with expenditures on other categories, the error terms in the Engle curve estimations are likely to be correlated, potentially leading to increased variance in the estimated coefficients and inefficient coefficient estimates. Because of this, we use an estimation method which is robust to the use of instrumental variables along with Seemingly Unrelated Regression (SUR). Hence, the paper estimates the system of Engel curves using Three-stage Least Squares (3SLS) method which is robust to the application of IVs in SUR. Because the dependent variables of the 12 equations add up to one (adding up restriction), we arbitrarily drop one equation from the system of Engel curves before proceeding with the 3SLS estimation. The equation on ''Miscellaneous goods'' is dropped here.

$$G_i = \alpha_{1i} + \alpha_{2i} afford + \alpha_{3i} P_e E + \delta_{0i} a + \beta_{1i} lnM + \beta_{2i} lnM^2 \qquad (1)$$

Where,

G_i = the budget share of commodity i in the remaining budget excess of expenditures on electricity

M = the total expenditure minus the expense on electricity bills.

A = the set of socio-economic characteristics of the households, like household size, age, average education of a household, dwelling type, number of rooms in a household, occupancy status of a household.

afford = the binary variable, takes the value 0 for the year 2013-14 and 1 for 2018-19

3.4 Data Description

Household cross section data from the household income and expenditure survey (HIES) for the years 2013-14 and 2018-19 collected by Pakistan Bureau of Statistics, Government of Pakistan is employed for this study. The data contain information on consumption expenditure for a wide variety of goods from 17,301[2] households in 2013-14 and 24,114[3] households in 2018-19. This nationally representative and official household consumption survey collected information on consumption of over 350 commodities in 2018-19 and more than 200 commodities in 2013-14. Expenditures on 12 distinct categories which are exhaustive and mutually exclusive, including food, tobacco, clothing & footwear, Housing & fuel, furniture, health, transport, communication, recreation & culture, education, restaurant and miscellaneous expenditure are considered for the analysis. The consumption module in HIES recorded expenditures on food items either as monthly or fortnightly expenditure. Similarly, in case of non-food items like tobacco products and energy and fuel commodities are recorded as monthly expenditure, while other non-food commodities as yearly expenditure (for instance, clothing, housing, recreation, education, health). For our analysis, all consumption expenditures are converted in average annual expenditures for both years.

Among households with electricity connections, vast heterogeneity in expenditure of electricity is noticed among income groups. Analyses are thus carried out for three income groups. The middle-income group represents households between the 3rd and 8th quintiles of the distribution of household income. Lower and higher income groups are those below and above this range.

[2] Total 17,989 households were sampled in 2013-14, however, 688 are excluded because of incomplete information.

[3] Total of 24,809 households, excluding Gilgit Baltistan and AJK, were sampled in 2018-19 HIES. However, 695 household are excluded during estimation because of incomplete information.

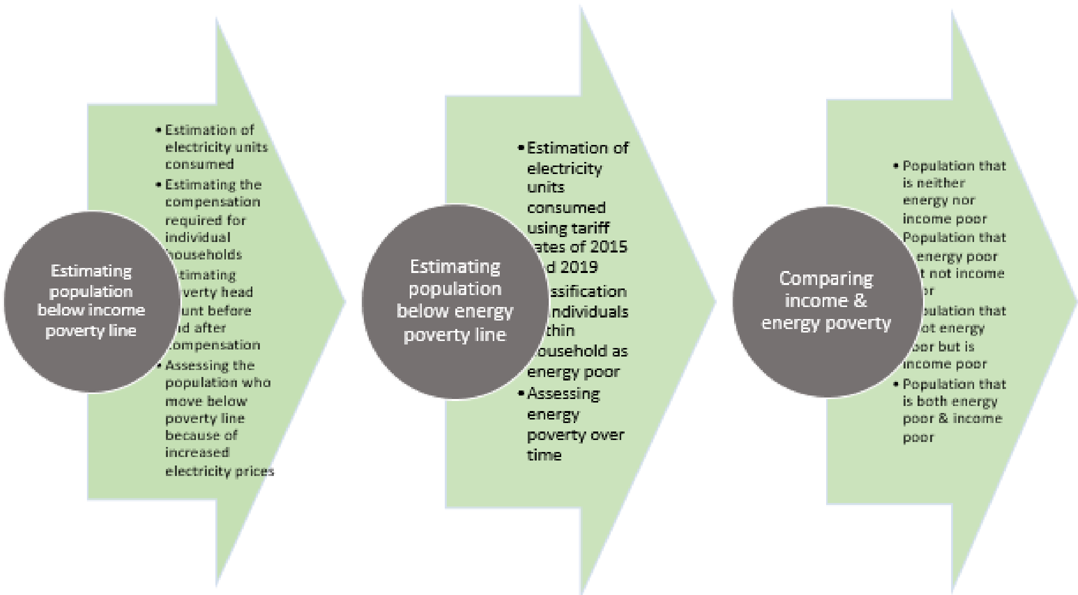
ELECTRICITY TARIFF REFORMS AND HOUSEHOLD WELFARE ANALYSIS FOR KARACHI CITY

Second foremost objective of the study is to examine the impact of changes in the electricity tariff structure on household welfare in the mega city, Karachi. More specifically, the study determines the proportion of population dragged below the poverty line, after being worse off as a result of the rise in electricity tariff. The study also estimates the proportion of proportion considered as energy poor using a minimum energy poverty threshold as suggested by Moss et. al. (2020). Moreover, the link between income poverty and energy poverty is explored. These core objectives are achieved by following a sequence of steps that begin by understanding the slab and tariff structure applied for residential electricity consumption and eventually leads to the welfare impact. Thus, the analysis demands an in depth understanding of the electricity tariff structure enforced. The slabs used for residential electricity consumption, tariff rates applicable as per the sanctioned load and duties such as GST, excise duties etc. are the key components of residential electricity prices.

4.1 Assessment Framework

The assessment framework is demonstrated in figure2.

Figure 2: Assessment Framework for the analysis

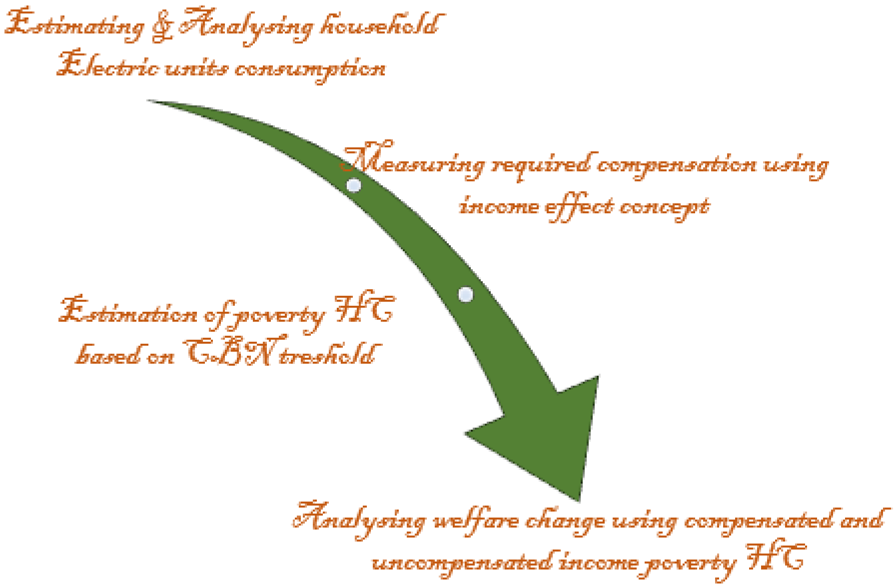


Source: Authors' Illustration

Analyzing the impact of electricity tariff on income poverty involves the steps portrayed in figure 3. As a first step, electricity units consumed by each household are estimated, which are based on their electricity expenditures.

It has been argued that increase in tariff worsen off individuals by reducing the income left for spending on other consumption goods and services. To estimate the compensation for the additional income that a household spent on electricity consumption, current and previous tariff structures are used. Assuming the household consumption patterns remains consistent, the compensation is measured for individual households in accordance with the slab they ended-up consuming in. Once the compensation is estimated, poverty head counts before and after compensation are measured using both national and international threshold. Finally, the welfare effect of rising electricity tariffs is reflected by the difference in the two head counts. It mentions those who move below poverty line because of increased electricity prices.

Figure 3: Steps involved in analyzing the impact of electricity tariff on income poverty



Source: Authors' Illustration

In the next step, energy poverty head counts are estimated using the estimated electricity consumption units for 2018-19 and 2015-16 for analyzing energy poverty over time. Finally, the study explores interconnections between income and energy poverty head counts.

4.2 Computation of Electricity Units Consumed:

As mentioned above, there are multiple steps involved in this analysis, where, each step is having its own methodology. For understanding the slab and tariff structure, an in-depth scrutiny of the available data from Ministry of energy and other tariff documents is conducted and presented in the introduction section. The electricity units consumed by the households are computed from Household Income and Expenditure Survey (HIES) 2018-19, published by Pakistan Bureau of Statistics (PBS). For determining the total electricity units consumed by households of mega city- Karachi- exogenously, slab-wise tariff rates specified by K-Electric for the year 2019 are used. As HIES provides electricity expenditures instead of electricity units consumed, the estimation for the electricity units consumed by the HH is performed backward from expenditures to units. The computational steps are given below.

Firstly, the household's electricity expenditures are adjusted to exclude 17% general sales tax (GST), 1.5% electricity duty and TVL fee of Rs 35 as

$$TEE_{HH} = TEE_{HH\_G} \left(\frac{100}{118.5}\right) - 35 \quad \text{... (2)}$$

Where,

TEE_{HH_G} = Gross household electricity expenditures inclusive of GST and TVL fee,

TEE_{HH} = Household electricity expenditures exclusive of these two.

Then, household's slab wise electricity expenditure disaggregation is estimated. Household's total electricity expenditure are simply the sum of expenditures in the second last slab and the highest slab they end up consuming in.

Mathematically,

$$TEE_{HH} = EE_{s-1} + EE_s \text{ .... (3)}$$

Where,

$$TEE_{HH} = STR_{s-1}(SEU_1 + SEU_2 + \cdots + SEU_{s-1}) + STR_i(EUC_s)$$

And

$$TEE_{HH} = STR_{s-1}(\textstyle\sum_{j=1}^{i-1} SEU_{s-1}) + STR_s(EUC_s) \text{ .... (4)}$$

Where,

s = Highest slab in which the HH ended up consuming,

EE = the electricity expenditure,

STR = the standard tariff rates,

SEU = the standard electricity units,

EUC = electricity units consumed in the highest slab.

Equation (4) shows that the household is charged for all the units consumed till the second highest slab as per the standard tariff rate of the second highest slab.

Total energy units consumed by HH are then aggregated till the slab in which the specific HH falls.

$$TEUC_{HH} = \textstyle\sum_{j=1}^{i-1} SEU_{s-1} + EUC_s \text{ .... (5)}$$

Where,

TEUC = the total energy units consumed by the household.

4.3 Estimation of Required Compensation by a Household

Assuming the household consumption patterns will remain consistent, household's compensation (C_{HH}) is estimated by taking the difference between household's electricity expenditures before and after the increase of tariff.

Mathematically,

$$C_{HH} = TEE_{HH}^{N} - TEE_{HH}^{P} \quad \text{.........................} (6)$$

Where,

TEE_{HH}^{N} = new (after tariff increase) electricity expenditure of a household,

TEE_{HH}^{P} = previous (before tariff increase) electricity expenditures of the HH.

To estimate equation (6), we substitute the values of total electricity expenditure from equation (4).

$$C_{HH} = [STR_{i-1}^{N} \, (\textstyle\sum_{j=1}^{i-1} SEU_{i-1}) + \; STR_{i}^{N}(EUC_{i})] - [STR_{i-1}^{P}(\textstyle\sum_{j=1}^{i-1} SEU_{i-1}) + \; STR_{i}^{P}(EUC_{i})] \text{.......} (7)$$

The household compensation amount estimated through equation (7) is then linearly combined with the current household income.

$$Y_{HH}^{C} = Y_{HH}^{UC} + C_{HH} \text{.........................} (8)$$

Where,

Y_{HH}^{UC} = uncompensated income,

Y_{HH}^{C} = household's compensated income.

Estimation of Equalized per Capita Income:

For estimating income poverty, equalized per capita income is calculated, using both national (Pakistan Planning Commission, 2015-16) as well as the modified OECD equalization scale[4] as mentioned in Haagenars et al. (1994).

$$EqY_{pc}^{UC} = \frac{Y_{HH}^{UC}}{Eq\ Size_{HH}} \quad \& \quad EqY_{pc}^{C} = \frac{Y_{HH}^{C}}{Eq\ Size_{HH}} \text{.........................} (9)$$

Where

EqY_{pc}^{UC} = equalized per capita (uncompensated) income,

EqY_{pc}^{C} = equalized per capita (compensated) income.

4.4 Estimation of Head Counts (HC) below Income Poverty Threshold

Finally, proportion of population below income poverty threshold is estimated by using equation (9) as:

$$\frac{HC_{UC}}{Tot.Pop} * 100, \; if \; EqY_{pc}^{UC} \leq Income\ Poverty\ Threshold \text{.........................} (10)$$

Similarly using compensated income

$$\frac{HC_{C}}{Tot.Pop} * 100, \; if \; EqY_{pc}^{C} \leq Income\ Poverty\ Threshold \text{.........................} (11)$$

[4] National equalization scale weigh individuals aged 18 and above as 1 otherwise 0.8. As per OECD head of the HH is given a weight of 1 while other adults and children are assigned a weight of 0.5 and 0.3 respectively.

Where,

$HC = \sum_{i=1}^{n} P_i$, P stands for poor individuals

Tot.pop = total population of country

i = individuals.

Income poverty is calculated using national and international poverty threshold. National poverty threshold using cost of basic needs (CBN) methodology of Rs 3250/adult equivalent/month (Pakistan Planning Commission, 2015-16) is used after adjusting it with CPI for reaching the threshold for 2018-19. For international poverty line, $ 1.25 threshold is taken after converting it in rupees using dollar exchange rate for 2018-19.

4.5 Energy Poverty

For estimating the proportion of population who are considered as energy poor (HC_E) a threshold of 300 KWh / person/ year is taken as standard following Moss et. al. (2020).

$$EUC_{PC} = \frac{TEUC_{HH}}{Size_{HH}} \quad \text{.......} \quad (12)$$

$$\frac{HC_E}{Tot.Pop} * 100 \quad if\ EUC_{PC} \leq Energy\ Poverty\ Threshold \quad \text{.......} \quad (13)$$

Where,

$HC_E = \sum_{i=1}^{n} EP_i$, EP stands for energy poor, *i* for individuals,

EUC_{PC} = electricity units consumed per capita in a household,

$Size_{HH}$ = total members in a household.

4.6. Karachi: A City of Light

In the previous section, we discussed the most rigorous methodology, which is employed in this study, to determine the impact of increase in tariff on income and energy poverty. However, there are certain limitations in the use of secondary data describe above. Firstly, the methodology for electricity consumption units discussed above is confined to use the standard slab-wise tariff rates under sanctioned load of less than 5kWh, as the HIES survey questionnaire does not have any question for the sanctioned load of the household. Hence, information regarding electricity consumption in peak and off peak hours cannot be incorporated in the methodology. Further, the estimation is adjusted for GST, TVL fee and electricity duty but not for other surcharges or taxes that may exist and are included in the household electricity expenditures. It is also worth mentioning that the electricity expenditures reported in the survey are usually not the exact expenditures as in the electricity bill but rather an approximation made by the household member interviewed.

Considering these caveats in the secondary data, the study conducted a primary survey of Karachi, named, "City of Light", as a case study for obtaining the in-depth information on energy situation. This study thus aims to form a rigorous analytical basis for energy policy making in Pakistan.

Primary survey regarding households' energy affordability and accessibility along with socio-economic conditions of a household is the need of an hour for conducting the in-depth analysis of rising electricity tariff on poverty. Keeping in view all these data caveats and limitations current study conduct an in-depth survey of electricity consumers in Karachi city[5].

Hence, in this section we describe sampling technique of the survey, and econometric specification of the models used in the analysis of survey data. However, questionnaire modules and results of pre-testing are included in annexure A5 and A6

Sampling Design and Survey Details

Table 4 provides the details of the households' sample selected from each town of Karachi. To reach an appropriate household sample, different combinations of confidence interval and specification errors were considered to remain statistically valid and representative. Given the above, it was considered an appropriate design, to determine the sample size with 95% confidence interval and less than 10% of specification error. The following formula was used, which yielded an optimal sample size of around 455 households:

$$\text{Optimal Sample Size} = Z^2 [p (1-p)]/e^2 \text{ (for known population)}$$

Where,

Z = Specification of confidence coefficient

p = Estimated Proportions of population (based on 2005 and projected population for 2020)

e = Specification error

The sample size was determined according to the proportion of population. Further, the town-wise estimated population was extracted from the 2017 census provided by Pakistan Bureau of Statistics.

[5] See Annexure B for complete Questionnaire

Table 4: Household Sample

S. No.	Town Name	Total Population	Proposed Sample	Actual Sample used
1	Baldia	616,721	20	20
2	Bin Qasim	480,855	15	15
3	Gadab	439,675	14	13
4	Gulberg	688,581	22	21
5	Gulshan-e-Iqbal	949,351	29	40
6	Jamshed	1,114,138	34	37
7	Kaemari	583,641	19	19
8	Korangi	829,813	26	26
9	Landhi	1,012,393	31	32
10	Liaqatabad	985,576	30	34
11	Lyari	923,177	29	30
12	Malir	604,766	19	20
13	New Karachi	1,038,863	32	34
14	North Nazimabad	753,423	24	21
15	Orangi	1,098,858	34	35
16	Saddar	935,565	29	30
17	SITE	709,944	22	23
18	Shah Faisal	509,916	16	17
	City Total	14,275,256	445	467

Source: Authors' calculations based on Pakistan Bureau of Statistics.

Econometric Model Specification and Variables Construction

To estimate the impact of electricity tariffs on household expenditures, the study has employed the following econometric model, based on simple regression analysis. Furthermore, the analysis is based on household-level primary survey of city Karachi.

$$\log(EXP_i) = \alpha_o + \alpha_1 Tariff + \alpha_1 HHC + \alpha_2 HC + \alpha_3 EV + \alpha_4 IQ + \epsilon \text{ .... } (14)$$

Where,

$\log(EXP_i)$ = household's expenditures on commodity i: food, health, education, clothing, transport, furniture, communication & recreation. This model is repeated for each commodity expenditure to analyze the impact of electricity tariff more comprehensively.

Tariff = household's electricity tariff.

HHC = household-level characteristics: household size, household average years of education and household average age.

HC = housing characteristics: number of rooms and area of the dwelling

EV = electricity related variables: sanction load in KWH

IQ = income quartiles (lower income, middle income & higher income)

In table 5 below construction of Variables used in equation (14) are described in detail.

Table 5: Table 5: Construction of Variables

Variables	Definition & Construction
Expenditures	Household's monthly expenditures on each commodity i
Tariff	It is the average tariff rate which is faced by the household, depending on the units consumed. It is obtained by dividing total electricity units expenditure by total electricity units consumed.
Household Size	The number of individuals in a household
Household Average Years of Education	The average completed years of education of a household
Household Average Age	The average age of all the members of a household
No. of Rooms	Total number of rooms in a dwelling
Area of the house	The total area of single residential unit
Sanction Load in KWH	The sanction load in KWH
Income Quartiles	Higher income (upper 20% of income group), Middle income (middle 60 % of income group) & lower income (lower 20% of income group)

Source: Authors' illustration

ANALYSIS AND DISCUSSION

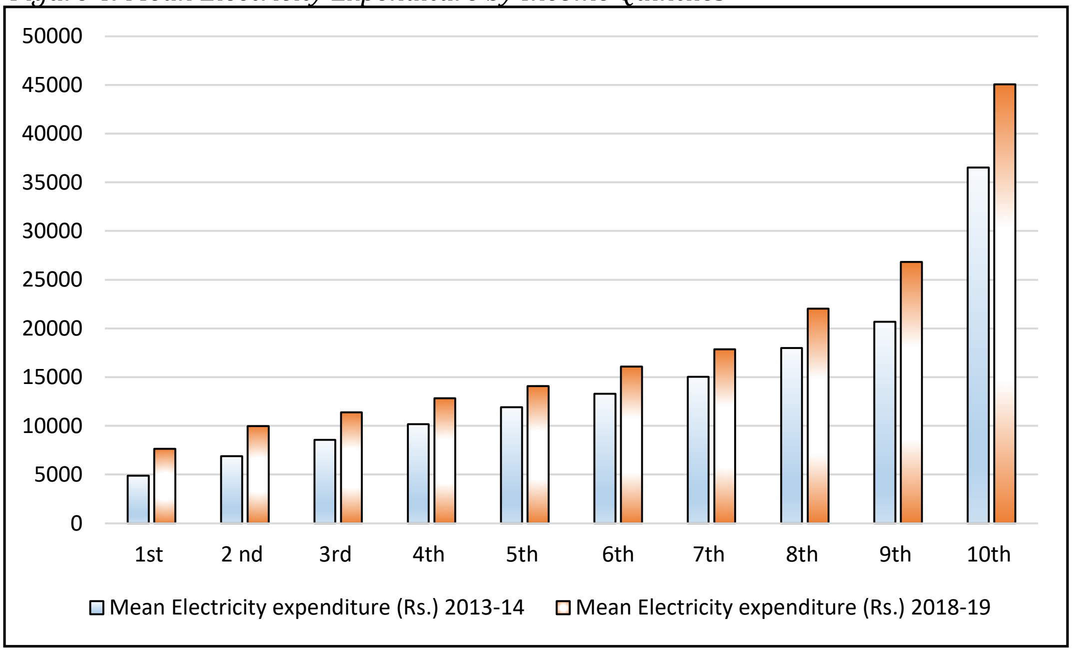
5.1 Crowding out Effect of Increased Electricity Tariff and its Implications on Household Resource Allocation

This section aims to study the difference in resource allocation of a household and thus the crowding-out effect of increased electricity tariff on household budget expenditure from 2013-14 to 2018-19.

According to HIES-2018-19, about 97 per cent of urban and 83 per cent of rural households are consuming grid electricity, hence reporting positive electricity expenditure for these households. All such electricity consumers are believed to be affected directly by increasing electricity tariffs.

Figure 4 shows a gradual increase in electricity consumption expenditure with income quintiles. In 2013-14, the average electricity expenditure for the lowest income quintile was less than Rs. 5000, which has increased by about 56 per cent to Rs. 7,632 in 2018-19. For the fifth quintile, mean electricity expenditures were Rs. 12000 in 2013-14 and reached to more than Rs. 14,000 in 2018-19, thus recording an 18.4 percentage point increase. While, for the highest income quintile, electricity expenditure increased by more than 23 percentage points between the two periods (from Rs. 36,525 to Rs. 45,070). This simple analysis shows that the lowest income group faced the highest increase in electricity expenditure, even though electricity price for the lowest three slabs remained unchanged from 2012 to 2018 (see table 2). This fact, however, points towards the other factors contributing to the electricity expenditure of households other than the tariff.

Figure 4: Mean Electricity Expenditure by Income Quintiles



Source: Authors' Illustration

Table 6 gives the mean consumption share of expenditure categories by income quintiles for households during the low electricity tariff (2013-14) and high electricity tariff (2018-19). Food group has the top share in consumption expenditure across all income quintiles. Yet, the percentage of food groups is comparatively higher in the lower-income households and lower in the higher-income households.[6]. Whereas, expenditure shares of furniture, transport, communication, recreation and education are comparatively higher in the higher income group and lower in the lower-income group.

Results of the Student's t-test for the differences in mean expenditures between the periods of high and low electricity tariff for low, medium and high-income groups are also reported in table 6. Expenditure category shares during the low tariff period are considered reference categories. Hence, a positive percentage point difference entails that households spend more, on average, to that consumption category during the high tariff period. In contrast, a negative percentage point change suggests less expenditure to that particular consumption category. T-stat columns show statistically significant differences in budget shares between the two periods for all income classes except health for low-income households, tobacco for middle-income households and health and education for high-income classes.

[6] In this study, the first two income quintiles are considered low-income groups, the middle six are middle-income groups, and the last two are considered high-income groups.

Table 6: Student t test for the difference in budget allocation between low and high electricity tariff

Expenditure categories	Low Income Households				Middle Income Households				High Income Households			
	Shares: Low tariff	Shares: High tariff	Difference	t-stat	Shares: Low tariff	Shares: High tariff	Difference	t-stat	Shares: Low tariff	Shares: High tariff	Difference	t-stat
Food & Beverages	51.03	46.08	-4.95	-17.6	45.38	42.46	-2.92	-20.3	35.10	34.42	-0.68	-2.3
Tobacco	1.77	1.49	-0.28	-4.2	1.25	1.24	-0.01	-0.6	0.73	0.85	0.12	3.6
Clothing & Footwear	6.62	8.07	1.45	18.0	7.20	8.25	1.05	23.8	6.91	7.83	0.92	11.1
Furniture	2.62	3.37	0.75	15.6	2.75	3.54	0.79	23.3	3.65	4.03	0.38	4.0
Health	3.55	3.68	0.13	1.4	3.34	3.54	0.2	3.8	3.48	3.33	-0.15	-1.0
Transport	4.73	4.00	-0.73	-6.5	7.23	6.31	-0.92	-12.3	10.31	8.29	-2.02	-10.5
Communication	1.64	1.49	-0.15	-4.5	2.09	1.73	-0.36	-17.1	2.74	2.35	-0.39	-8.2
Recreation & Culture	1.78	1.15	-0.63	-8.2	1.96	1.45	-0.51	-15.6	2.08	1.44	-0.64	-11.7
Education	0.68	0.48	-0.2	-4.7	2.27	2.06	-0.21	-4.3	4.93	5.18	0.25	1.5
Restaurant	2.33	3.39	1.06	6.0	1.77	2.42	0.65	12.1	2.41	3.02	0.61	5.5
Housing, water and fuel	16.16	20.27	4.11	18.9	16.04	18.70	2.66	23.6	16.45	18.76	2.31	9.7
Misc.	7.09	6.53	-0.56	-5.6	8.72	8.30	-0.42	-6.7	11.20	10.50	-0.7	-3.6

Source: Authors' Calculation

The differences in resource allocation observed in table 6 for various expenditure categories do not control for demographic and socioeconomic characteristics of households. To examine the crowding-out effect, more vigorous and theoretically sound econometric analyses are carried out by employing the conditional demand model as expressed in equation 1. In this section, the used model, which is conditional on electricity expenditure, is estimated, firstly, to test whether the increased tariff alters the preferences over the commodity categories from one period to another. Secondly, this model statistically examines the nature of crowding out of other categories because of increased electricity expenditure- as a result of increased tariff- controlling for demographic and socioeconomic characteristics of households.

Table 7 shows adjusted differences of increased tariff for different income levels. It demonstrates the mean share of expenditures on various categories (columns 2, 4, 6) during the low tariff period (2013-14), considered the reference category. Similar to table 6, positive percentage point difference implies that households, on average, allocated a more significant share to that consumption category during the high tariff period than the low tariff period. In contrast, a negative percentage point difference implies households allocated a smaller share in the high tariff period.

Table 7 Adjusted Differences of Increased Tariff on Expenditure Shares by Income Groups:

Expenditure categories	Low Income Households (lower 20%)		Middle Income Households (Middle 60%)		High Income Households (Highest 20%)	
	Low Tariff	High Tariff	Low Tariff	High Tariff	Low Tariff	High Tariff
	Mean Share (%)	Difference (% point)	Mean Share (%)	Difference (% point)	Mean Share (%)	Difference (% point)
Food & Beverages	51.03	0.84***	45.38	-0.14	35.10	-1.79*
Tobacco	1.77	0.27*	1.25	0.17*	0.73	0.14*
Clothing & Footwear	6.62	0.73*	7.20	1.18*	6.91	1.11*
Furniture	2.62	0.53*	2.75	1.00*	3.65	-0.83*
Health	3.55	-0.19*	3.34	0.66*	3.48	1.92*
Transport	4.73	-2.72*	7.23	-1.57*	10.31	0.29
Communication	1.64	-0.18	2.09	-0.13	2.74	-1.28*
Recreation & Culture	1.78	-1.04*	1.96	-0.98*	2.08	-1.06*
Education	0.68	-1.10*	2.27	-1.66*	4.93	-2.79*
Restaurant	2.33	4.06*	1.77	1.52*	2.41	0.01
Housing, water & fuel	16.16	-1.59*	16.04	-0.16	16.45	3.97*

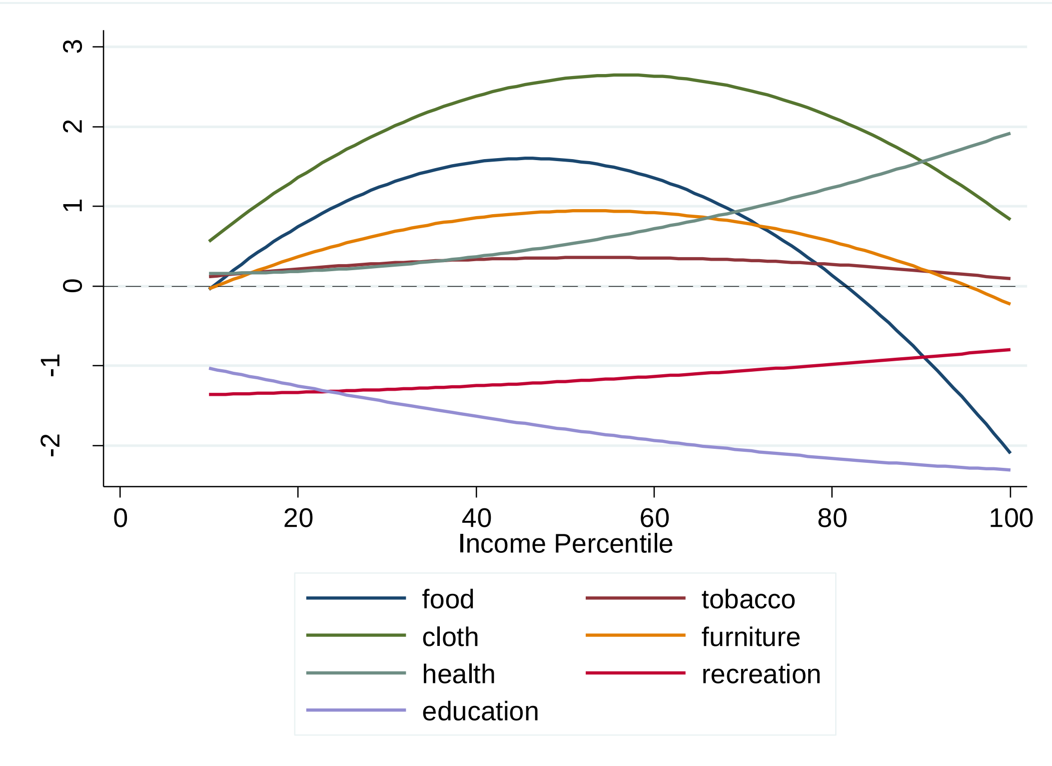
Source: Authors Calculation

Table 7 reveals statistically significant differences in expenditure allocations for most of the expenditure categories. For instance, after the increase in tariff, low income households, on average allocated less on health, transport, communication, recreation, education, housing & fuel. While allocated share on most of the necessities, like food, tobacco and clothing has been increased. More or less similar pattern is observed for middle income households, except that their allocated share for food & beverages shows statistically insignificant results, while allocated share on health has increased to 0.66 percent. High income households also altered their budgets except for transport and restaurants.

Similar to the estimated results shown in table 7, the adjusted differences are estimated using equation 1 for household expenditures at the 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100th income percentiles. Coefficient estimates for α_{2i} from equation 1 are statistically significant for the consumption groups (i.e. food, tobacco, clothing, furniture, health, recreation and education) as demonstrated in figure 5. Adjusted differences < 0 means households allocated less resources to the consumption group after the increase in tariff.

Figure 5 illustrates that adjusted differences in the food and beverages share has increased for low and lower-middle income households' consumption expenditure distribution, and is gradually decreasing for higher-middle income households, while negative for higher income households. It is also observed that the magnitude of the difference is greater for higher income households. In 2018-19 (period of tariff increase) at the 90th percentile, households allocated about 2 percentage point less of household spending on food and beverages compared to the period of 2013-14.

Figure 5: Adjusted Differences in Consumption Share by Income Percentiles



Source: Authors' Illustration

Adjusted differences in the clothing or apparel share are positive at entire household expenditure levels. In contrast, adjusted differences for education and recreation is negative for entire households. At the 10th percentile (lower-income households), the mean share of education is 1.15 per cent less. At the 60th percentile (middle income), the mean share of education is two percentage points less. While at the 100th percentile (high-income households), the mean share of education is 2.64 percentage points less. Adjusted differences in the health expenditure share, on the other hand, are positive at all levels of household expenditure distribution; however, the magnitude of the difference is lower for low-income households and higher for high-income households.

These results show a nontrivial difference in the composition of budgetary expenditures of households during the low tariff period compared to the high tariff period. An increase in the cost of electricity has a direct and indirect effect on welfare. It is well documented that electricity prices sometimes bring macroeconomic instability, like, rising inflation and higher unemployment rates, thus hurting the poor, Moshiri, (2015). Therefore, on the one hand, the indirect effects of increased electricity prices compelled the poor households to cut their spending on commodities other than necessities. While on the other hand, it raises the cost of different food and non-food items, which increase the expenditure of poor households on essentials.

Table 8: Crowding-in and Crowding-out by Income Group

Expenditure Category	Low Income Households		Middle Income Households		High Income Households	
	Crowding-in	Crowding-out	Crowding-in	Crowding-out	Crowding-in	Crowding out
Food & Beverages		✓		✓	✓	
Tobacco		---		✓	✓	
Clothing & Footwear	✓		✓		✓	
Furniture	✓			✓	✓	
Health	✓			✓		✓
Transport	---			✓		✓
Communication	✓			---	✓	
Recreation & Culture		✓	✓		✓	
Education	✓		✓		✓	
Restaurant		✓		✓		✓
Housing, water & fuel	✓		✓			---

Source: Authors Calculation

In the context of the current study, the crowding-out effect is the mechanism through which rising electricity expenditure negatively impacts households' well-being due to the alteration of consumption of necessities because of spending on electricity. Table 8 show the regression outcomes for the crowding-out effect of electricity expenditure for various income groups. Estimates of α_{3i} in equation 1 are significant for all the categories except for tobacco and transport for low-income groups, communication for middle-income groups and housing, water & fuel for the higher-income group. The heterogeneous crowding out effect of electricity expenditure for various income groups is revealed. An increase in the outlay of electricity leads to a fall in the budget shares devoted to food, tobacco, recreation and restaurant for low-income households. The crowding-out effect of electricity expenditure on the middle-income household is the most significant. An increase in electricity expenditure crowded out almost all the allocated shares for various expenses except for clothing, recreation and education. For high-income households, increased electricity expenditure crowded-in all expenditure shares except for health, transport and restaurant.

Table 9 shows that for low-income households, Rs.1000 increase in electricity expenditure is accompanied by a 1.24 percentage point decrease in food expenditure. For the middle-income group, electricity expenditure crowded out most of the expenditure categories but with relatively slighter percentage points. Whereas, for the high-income class, Rs. 1000 increase in electricity expenditure leads to 0.28 and 0.33 percentage points decrease in health and transport expenditures.

Table 9: Crowding-out effect of electricity expenditure by Income Group

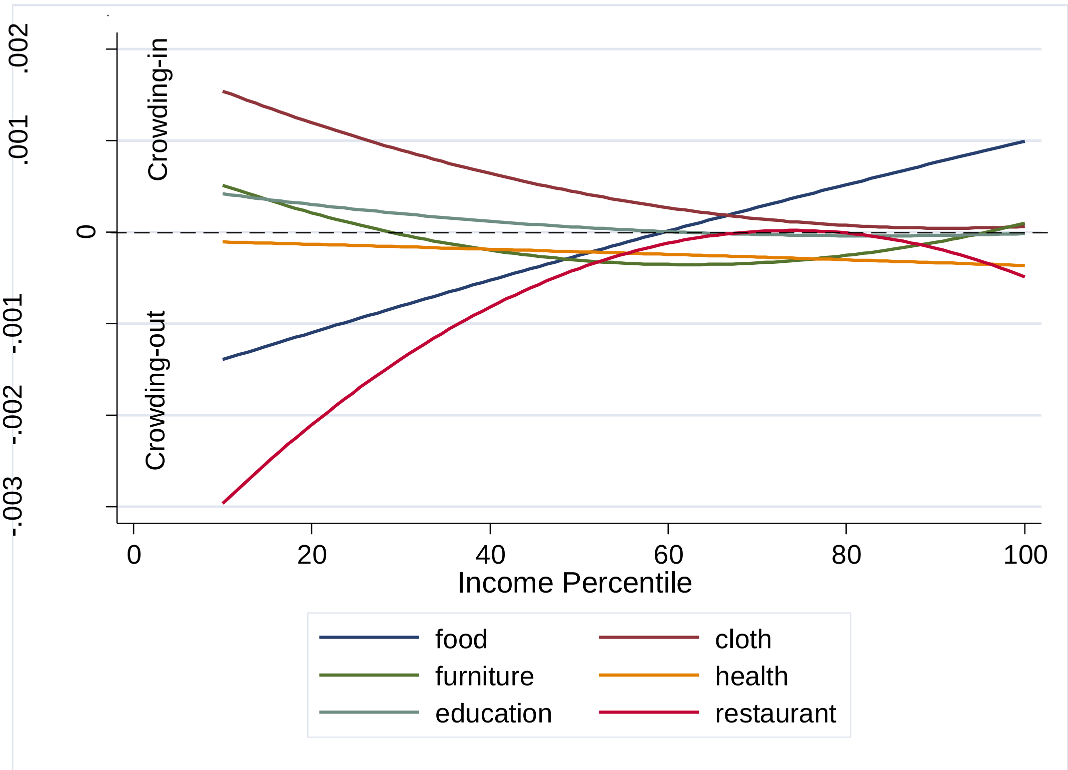
Expenditure Category	Low Income Households	Middle Income Households	High Income Households
Food & Beverages	-0.00124*	-0.00017*	0.00061*
Tobacco	-0.00003	-0.00002*	0.00002*
Clothing & Footwear	0.00157*	0.00023*	0.00006*
Furniture	0.00031*	-0.00018*	0.00012*
Health	0.00009**	-0.00029*	-0.00028*
Transport	0.00001	-0.00008*	-0.00033*
Communication	0.00029*	-0.00001	0.00010*
Recreation & Culture	-0.00027*	0.00004*	0.00002*
Education	0.00032*	0.00022*	0.00007*
Restaurant	-0.00272*	-0.00049*	-0.00002**
Housing, water & fuel	0.00189*	0.00138*	-0.00004

Source: Authors Calculation

Figure 6 shows the crowding out effects estimates for various income percentiles. Estimates in the Y-axis are computed by employing equation (1) for expenditures at 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, 90th and 100th percentiles. Coefficients for α_{3i} from equation (1) are statistically significant for the expenditure categories, like, food, clothing, furniture, health, education and restaurant, are graphed in figure 6. Values in the vertical axis refer to adjustment in consumption expenditure share for the particular category due to increase in electricity expenditure by Rs.1. Values less than zero in the vertical axis are considered as crowding out, and on the other hand values greater than zero describe as crowding in.

The most important point to be noticed in figure 6 is that the size of crowding in and crowding out effects are greater for poor households. It has been demonstrated that electricity expenditures crowded out food expenditure in lower and middle income households, while crowded-in for higher income group households. However, the size of crowding out effects are higher for poorest percentiles. Health expenditures are crowded out at all income levels. As far as education expenditures are concerned, crowding in is noticed for lower income groups, while crowding out with insignificant magnitude is noticed for higher income percentiles. The largest magnitude of crowing out is noticed for restaurant expenditures for poorer households. At the 10th percentiles (poorest households) of household expenditures, a Rs1000 rise in electricity expenditure leads to 4 percentage point fall in restaurant expenditure.

Figure 6: Crowding-out of consumption by Income percentiles



Source: Authors' Illustration

Under-nutrition is already the main reason for infant mortality in Pakistan, Hussain et al. (2018). Crowding out of food and beverages consumption might have implications for children's physical and intellectual growth and the nutritional deficiency in mothers, notably, for lower-income households. Electricity expenditure, through increased tariffs, could further deepen the nutrition uncertainty by reducing food expenditures.

Results show that the displacements due to electricity expenditure occur for commodities that constitute human capital investments, like food and nutrition, health etc., thus having severe implications on households' well-being. Electricity tariff reforms, with the nonexistence of adequate health compensation, insurance or other public provision of finances, could lead to welfare loss, particularly among poor households. Hence, inadequate measures by the Government could adversely affect human capital investments crucial for long-term prosperity.

It is also worth mentioning that some limitations have been noticed in the study. Firstly, consumption expenditure data for all categories, including electricity expenditures, are estimated and self-reported values, and not the exact ones. Therefore recording or misreporting mistakes could create biases in the crowding out computations.

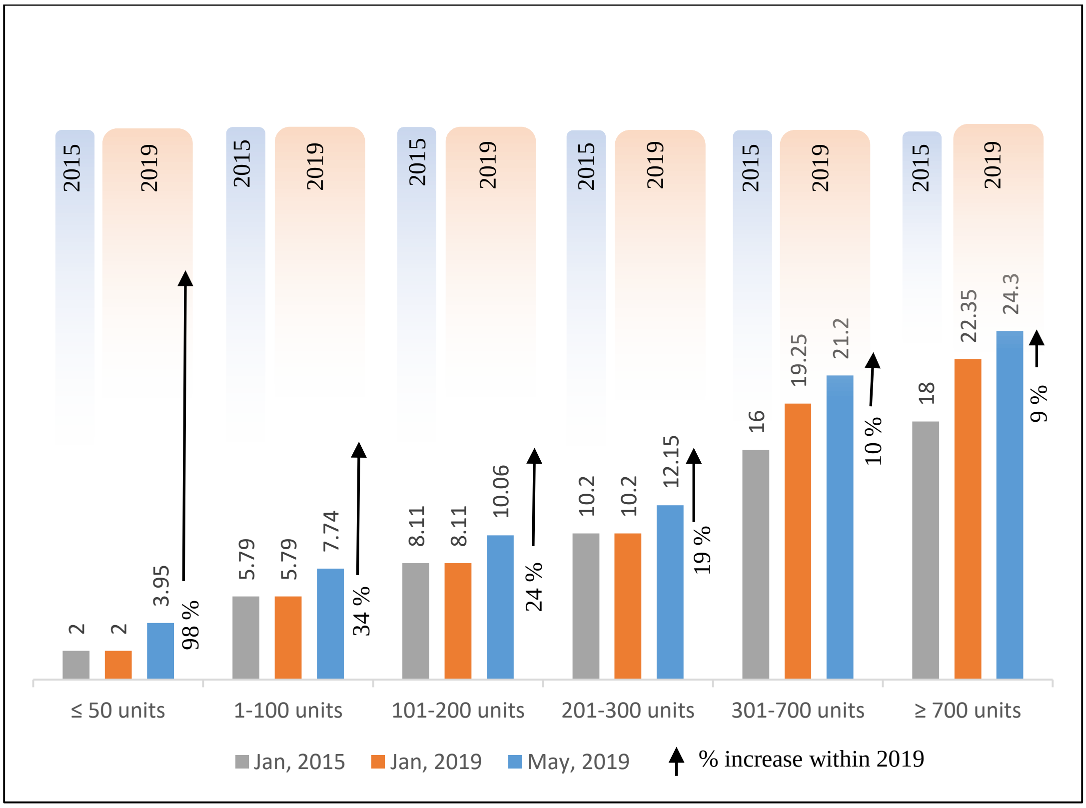
5.2 Electricity Tariff Reforms and Household Welfare Analysis for Karachi City

This section estimates the welfare impact by employing HIES 2015-16 and HIES 2018-19 for Karachi city as a case study.

For achieving these objectives, we first analyzed the increase in tariff rates from June 2015 to January 2019 and then from January 2019 to May 2019. Figure 7 shows that the residential electricity tariff rates remained unchanged from June 2015 till January 2019, except for the two higher slabs. Such reform aimed to safeguard consumers with relatively inelastic electricity consumption in lower slabs. However, per unit tariff rates for higher slabs are increased, considering elastic electricity consumption at higher slabs, thus discouraging inefficient use of electricity on the one hand and reducing fiscal pressure on the other.

However, in May 2019, the tariff rates were increased by a flat rate of Rs 1.95 per unit. In percentage points, this increase is more oppressive for lower slab consumers, particularly for lifeline consumers. Black arrows in figure 7 show that the impact of a flat rate increase is more burdensome for consumers in lower slab compared to the upper slab consumers.

Figure 7: Change in residential electricity tariff from 2015 to 2019

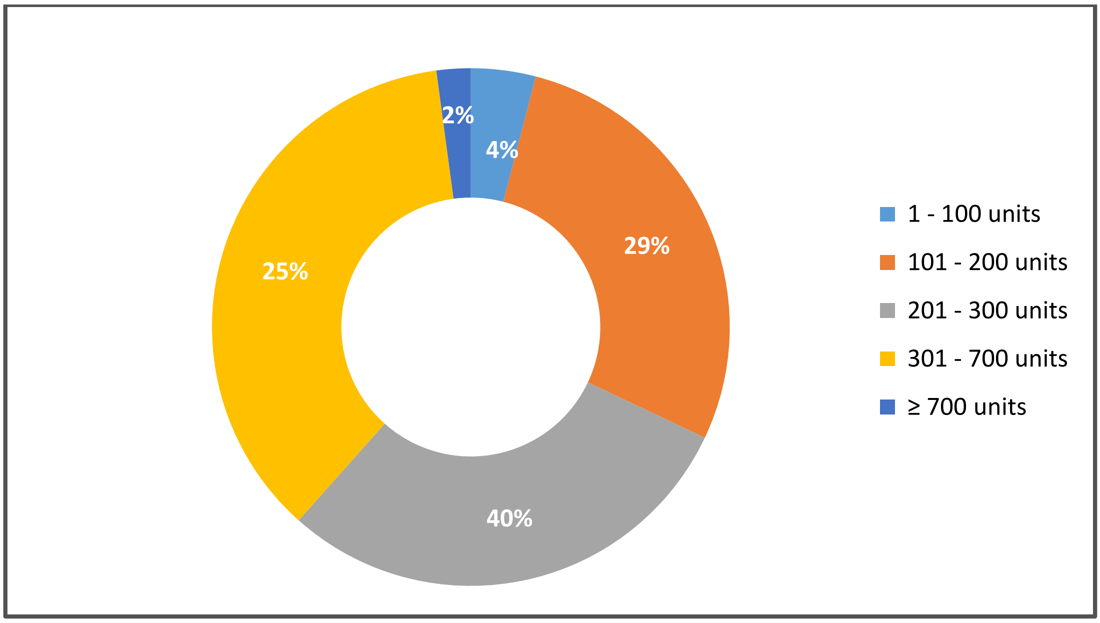


Source: Authors' illustration using KE applicable tariffs

According to figure 3, the first step of estimation in this section involves computing electricity units consumed by each household. Figures 8, 9 and Table 10 describe unit consumption of electricity computed from HIES 2015-16 and 2018-19 for Karachi city.[7] By employing June 2015 and January 2019 tariff rates, respectively.

[7] In 2015-16, information of 2,446 households for Karachi city is available, while in 2018-19, 1,413 households were included in the survey.

Figure 8: Slab-wise Electricity Consumption (% of Households)



Source: Author's estimations

Figure 8 displays the estimated percentage of households in each consumption slab in 2019. It shows that only 2 percent and 4 percent households consume electricity in the 5th and 1st slabs respectively. While around 94% of households are consuming in the 2nd, 3rd and 4th slabs. It is worth mentioning that households consume in lifeline tariff slab cannot be computed from HIES data. However, according to Walker T. et al., (2014), lifeline tariff rate is ineffective in Pakistan, as merely around 3 percent of households consume below 50 KWH. Hence, this limitation are assumed not to alter the results, significantly.

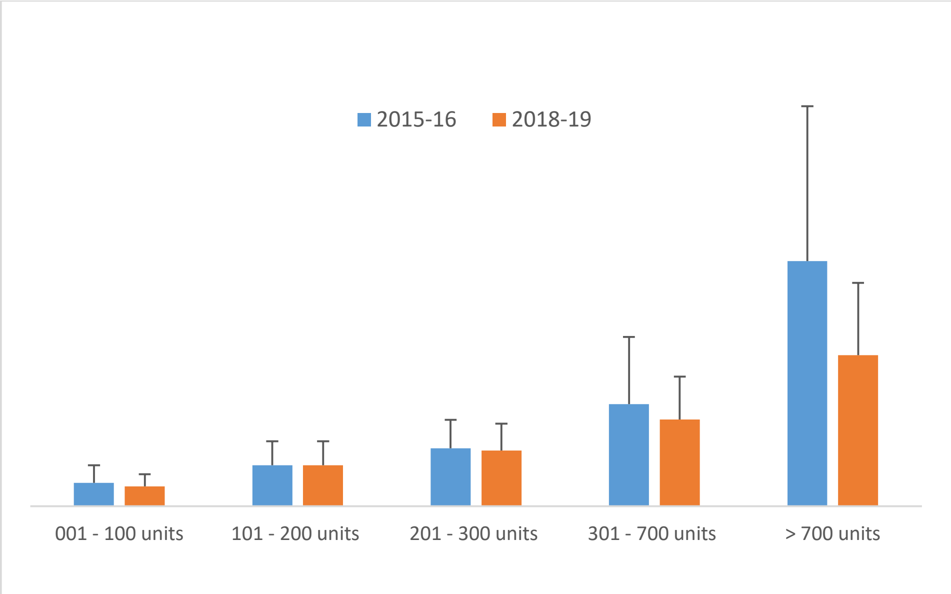
Table 10: Percentage of Households by HH Income Quintiles and EC Slabs (2019)

% of HHs across HH Income quintiles and EC slabs (2019)						
Unit Slabs	HH Monthly Income Quintiles					Total
	1st	2nd	3rd	4th	5th	
1 - 100 units	63.16	22.81	8.77	3.51	1.75	100
101 - 200 units	45.57	26.33	17.22	8.61	2.28	100
201 - 300 units	22.78	28.06	20.14	21.34	7.67	100
301 - 700 units	12.89	9.77	20.31	22.27	34.77	100
≥ 700 units	0	0	6.67	6.67	86.67	100
Total	26.71	20.13	18.64	17.08	17.43	100

Source: Author's Calculation

Table 10 reveals the estimated households within each electricity consumption slabs and income quintile. It is observed that lower-income households consume, on average, less units of electricity compared to higher income households.

Figure 9: Deviation from mean electricity consumption by slabs



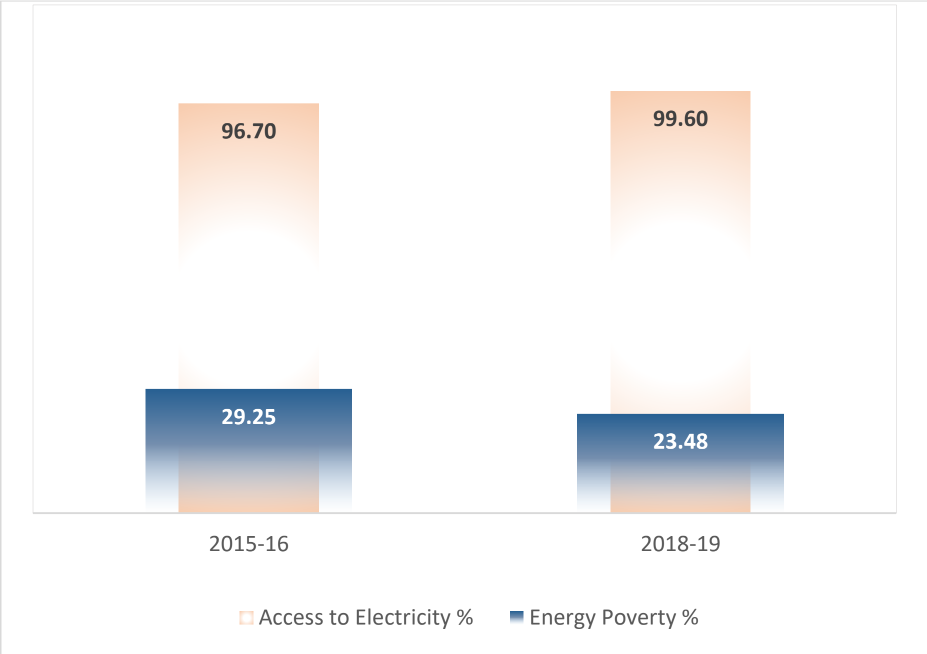
Source: Author's Calculation

This graph (figure 9) represents the deviation of average consumption in each electricity consumption slab. The vertical lines above the bars reflect the deviation from the mean within a specific slab. It can be seen that the deviation is increasing as we move towards higher slabs indicating that electricity consumption in lower slabs is relatively inelastic in comparison to upper slabs. Thus, any price increase worsens households in lower slabs relatively more than the households in the upper slabs. In contrast, the benefits to upper slab consumers will be more significant in relation to the lower slab households for any price decline.

Energy Poverty

Given the energy threshold and electricity units' estimates, energy poverty for 2015-16 and 2018-19 is calculated. Interestingly, figure 10 shows that the population below the energy poverty threshold in 2015-16 was 29.3 per cent while it decreased to 23.5 per cent in 2018-19, despite the increase in tariff. The figure demonstrates that access to grid electricity has also been increased significantly during this period. Hence, increased access may reduce energy poverty in Karachi city during this period.

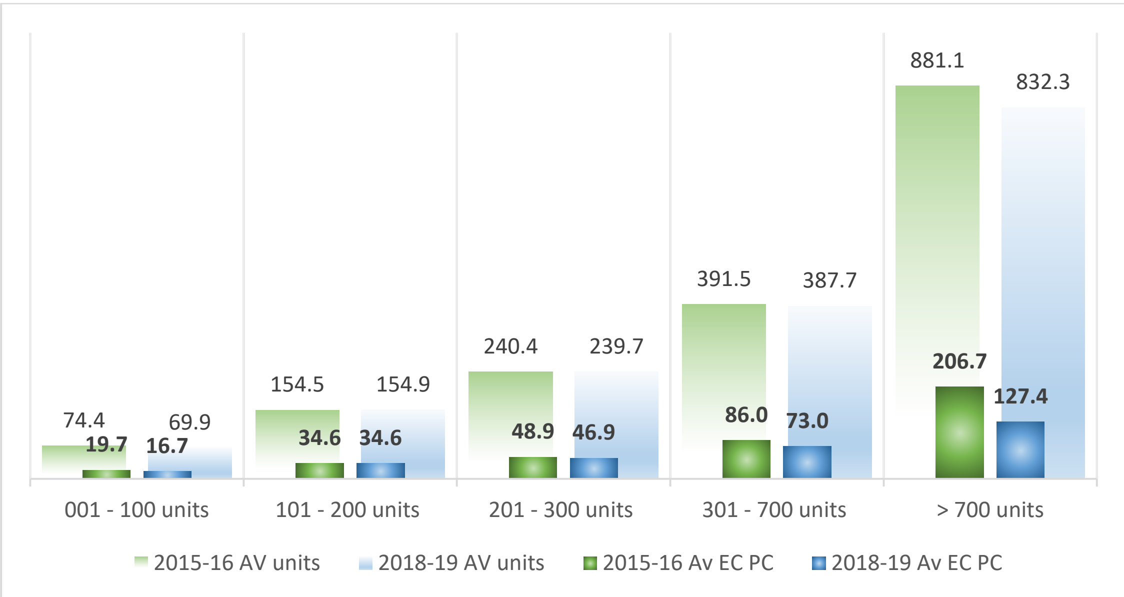
Figure 10: Percentage of population below energy threshold



Source: Author's estimations

Further, for exploring the tariff effect on energy consumption, average energy household consumption and average per capita energy consumption by electricity consumption slabs is also analyzed. Figure 11 below reflects that both, households' electricity consumption as well as per capita electricity consumption, declines over time for upper two slabs. However, for lower slabs electricity consumption is almost unchanged.

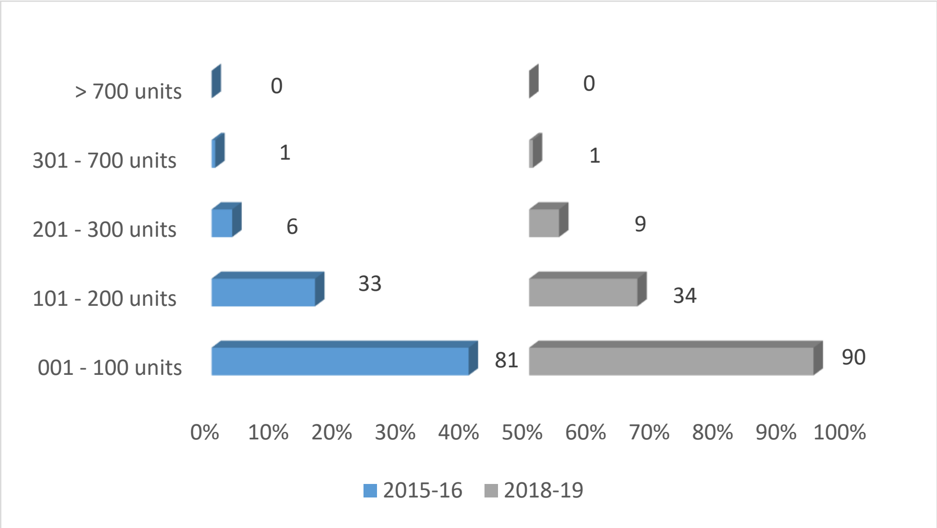
Figure 11: Electricity Consumption Units by Electricity Consumption Slabs



Source: Author's estimations

Figure 12 confirms that majority of energy poor laid in lower electricity consumption slabs in both years. Lower electricity consumption slabs usually comprises of greater proportion of lower income households. It is shown that 81 percent of the population consuming in slab one are energy poor and this percentage increased to 90 % in 2018-19. For the second and third slab proportion of energy poor increased over time.

Figure 12: Proportion of energy poor by electricity consumption slabs (%)



Source: Author's estimations

Income Poverty

Table 11 shows the increase in income poverty as a result of increased tariff from January 2019 to May 2019. Uncompensated household income is the income of households if no compensation would be provided for the rise in tariff rate, however, compensated income is calculated by adding the increased amount that a household has paid as a result of increased tariff in the total income of households. The amount of compensation is thus calculated as the difference between the compensated and uncompensated household income. Table 11 shows the proportion of poorest households living below poverty line by employing standard thresholds and equivalency scales.

Table 11: Percentage of income Poor Population in Karachi

	National Equivalency Scale	OECD Equivalency Scale
	HC international Poverty Line $ 1.25= Rs 170.11	
Uncompensated HH Income	37.74	3.82
Compensated HH Income	33.08	3.20
Change in Poverty	4.67	0.63
	HC national Poverty Line Rs 125.87	
Uncompensated HH Income	14.52	1.14
Compensated HH Income	12.49	0.92
Change in Poverty	2.03	0.22

Source: Authors' Estimation using HIES 2018-19

In Karachi city, around 38% and 4% of the population is below the international poverty threshold of $ 1.25 per day per adult equivalent using the national and OECD equalization scale. However, as per the national income poverty threshold based on the cost of basic need (CBN) methodology and national equivalency scale, approximately 14.5 % population in Karachi is income poor. Using the same threshold with the OECD equivalency scale results in about 1.14 % income poverty. Poverty estimates using OECD equalization standards are less than those calculated using the national one because of the difference in assigning weights to the members of the households.

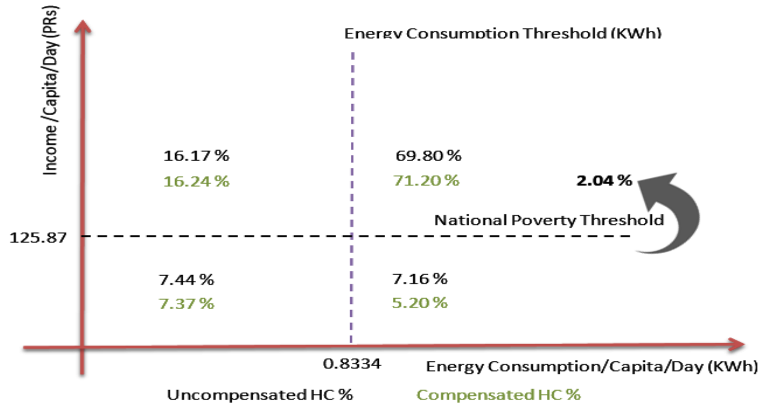
It has been estimated that if the compensation had been provided to the poor households, all the poverty estimates reported in the third and seventh row of table 11 would be declined. Considering only the national equalization scale, about 4.7 per cent of the poor population would be pulled above the international poverty threshold. In contrast, around 2 per cent of the poor population would be able to escape the national CBN poverty threshold. These estimates, however, indicate the impact of electricity tariff increase in inflating income poverty in Karachi city on the one hand while describing the significance of compensatory mechanism in reducing poverty on the other.

Finally, to explore the interconnection between income and energy poverty, the plots below categorize all the surveyed households into four groups. Per capita energy consumption per day is measured along the x-axis, while income per adult equivalent per day is plotted along the y-axis. The vertical dashed line represents the electricity consumption threshold. Individuals consuming below the dashed line are considered energy poor. At the same time, the horizontal dashed line measures the minimum income threshold. Individuals with income below these thresholds are considered as income poor.

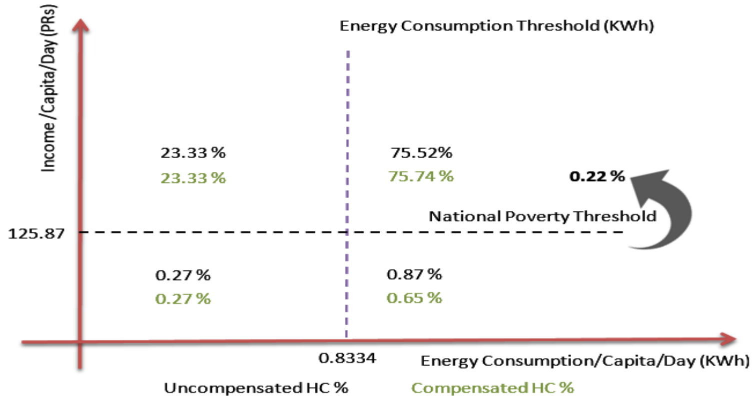
Figure 13 pooled the impact of tariff reforms in exacerbating the energy poverty and income poverty in Karachi city. Figure 13 (a) and (b) are based on the national adult equivalency scale, and (c) and (d) are computed on the OECD adult equivalency scale.

Figure 13: Income and Energy Poverty Before and After Compensation

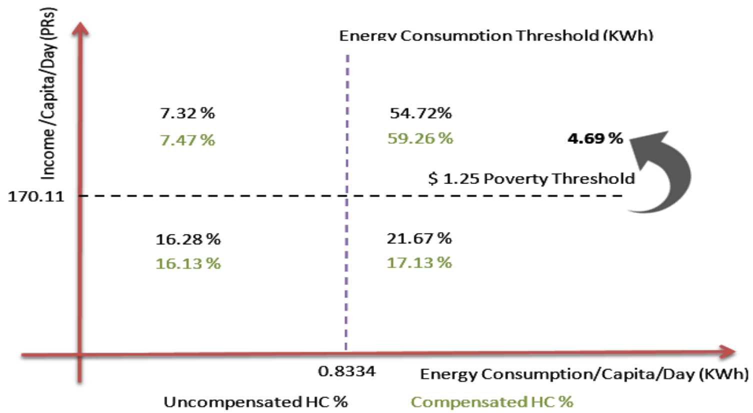
(a) National Poverty Threshold & National adult equivalency scale



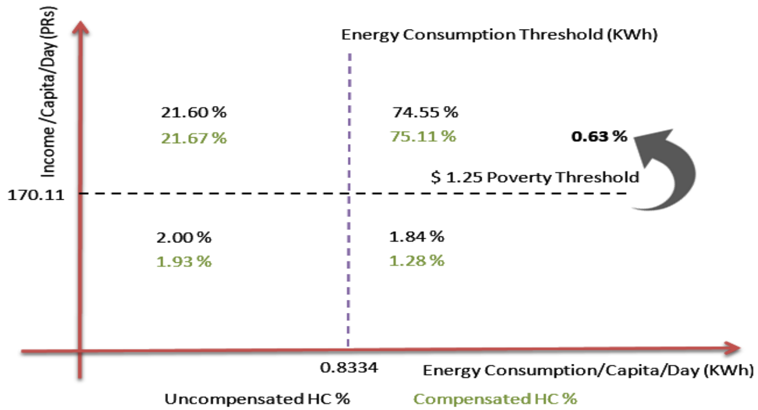
(c) National Poverty Threshold & OECD adult equivalency scale



(b) International Poverty Threshold & National adult equivalency scale



(d) International Poverty Threshold & OECD adult equivalency scale



Source: Authors' estimations using HIES 2018-19 and KE data.

Figure 13 (a) split the population on the basis of national poverty threshold of Rs 125.87 per day per adult equivalent. It depicts that about 69.8% of population lies in the 4th quadrant that are neither income nor energy poor while 7.44% population are the most deprived as facing both income and energy poverty. Around 7.16 percent population are income poor but not energy poor, while 16.17 percent population fall in the polar opposite group. If the compensation would have been provided, around 2.04 percent population that is below income poverty can be dragged above poverty threshold. Whereas, figure 13(c) reveals that after compensation, decrease in income poverty would be about 0.22%.

Figure 13 (b) is plotted for $1.25 international poverty threshold. It shows that 37.9% population are found income poor of which 16.28 percent population are energy poor as well. After compensation this estimate would reduce to 33.26 percentage point, hence, showing 4.69 percent decreased in headcount ratio. At least 54.72 percent population are still out of the income and poverty threshold. Considering OECD scale, however, the headcount estimates reduced by 0.63%.

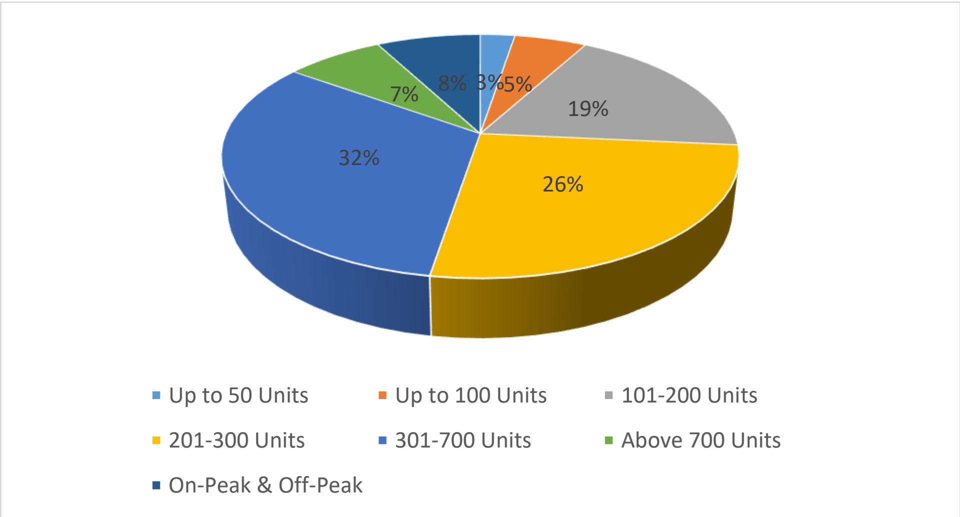
It is concluded that whatever threshold is being used as a policy tool, impact of electricity reforms could be mitigated only through more comprehensive and long lasting compensatory mechanism.

5.3. Findings of Survey, "Karachi: The City of Light"

Previous section provided the detail assessment of increased electricity tariff on household welfare of Karachi city by employing the HIES dataset. As mentioned earlier, there are limitations in PSLM/HIES dataset for comprehensive energy policy analysis. Hence, the primary survey, titled, "Karachi: The City of Light", incorporate the energy modules into PSLM/HIES survey. The information gathers, provide greater insight into the role of energy prices on household welfare.

This section of the study discusses the findings, which is based on descriptive and empirical analysis of the household-level primary data of Karachi city. The descriptive analysis presents the consumption, expenditure and change in recent increase in electricity tariff by electricity consumption slabs. The analysis also provides estimates of the empirical model discussed in equation 14. The last part, however, provides information on energy literacy, consumers' satisfaction and behavior of households regarding electricity use.

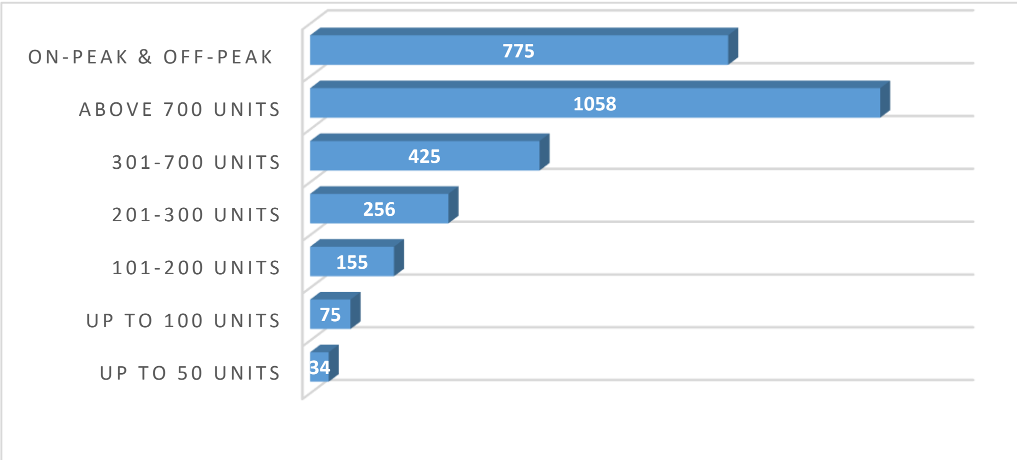
Figure 14: Households by Electricity Slabs (%)



Source: Authors' illustration based on primary survey of Karachi.

Figure 14 above illustrates percentage of households in each consumption slab. Figure depicts that most of the households consume in the middle slabs, i.e. 32 percent in the 5th slab (301-700), 26 percent of households in 4th slab (201-300) and 19 percent in the third slab. As noticed by Walker T. et al., (2014), survey results validate that lifeline tariff slab is nearly ineffective in Pakistan as meagre 2.57 percent of households are consuming in lifeline slab of less than 50 units per month. Proportion of households consuming in the lowest and highest slabs are also relatively low. Whereas, ToU tariff is applicable to households having sanctioned load equal to or greater than 5 kWh. Hence, according to the survey results, only 8 percent of households fall in this category.

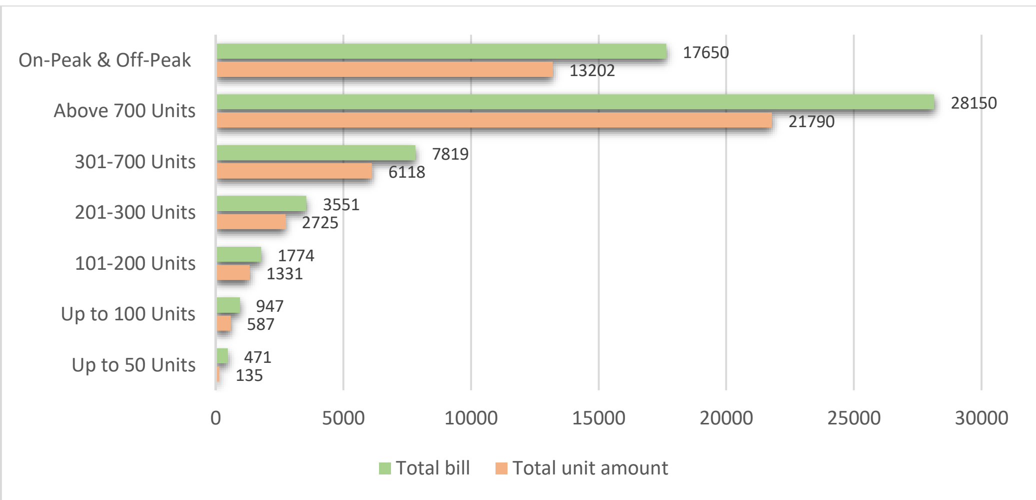
Figure 15: Average Monthly Electricity Consumption (Units)



Source: Authors' illustration based on primary survey of Karachi.

Figure 15 portrays the average electricity consumption in units by electricity slabs. Figure depicts that on average, the highest units of electricity (1058) are consumed by only 7 percent of households. Following this, on average, about 775 units of electricity per month are consumed by only 8 percent of households that belong to the ToU category. However, the highest proportion of the households of Karachi, i.e. 32 percent, on average consume only 425 units of electricity per month. This is followed by an average consumption of 256 units by 26% of households.

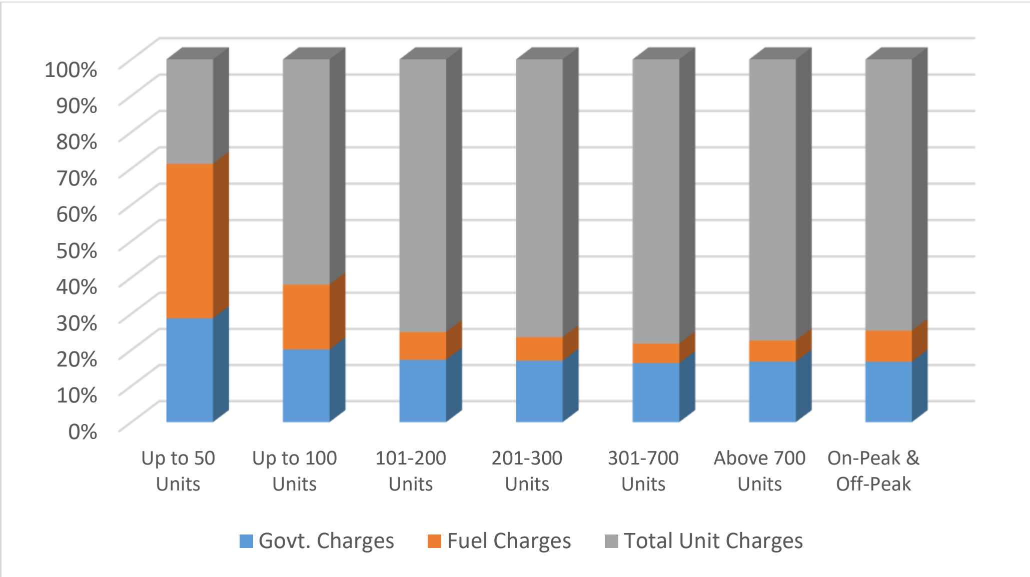
Figure 16: Average Monthly Electricity Expenditures (Rupees)



Source: Authors' illustration based on primary survey of Karachi.

Figure 16 illustrates the average expenditures of electricity by the households of Karachi. The smaller bar in each slab represents the consumption expenditure of units (kWh), while the bigger bar shows the total amount of the electricity bill inclusive of government charges, fuel adjustment charges etc. Figure depicts that on average, households consume more than 700 kWh per month pay about three times more than the households that end-up consuming just below 700 kWh. Similarly, the difference in the expenditure between households that consumes in fourth (201-300 units) and fifth slab (300- 700units), is about two times. Another significant feature of figure 16 is that the government charges and other charges like TVL fees, fuel adjustment charges etc. constitute significant proportion of total bills. Figure 17 thus shows the disaggregation of total billing components for each slab.

Figure 17: Comparison of Unit Expenditure with Other Charges of Electricity (Rs)



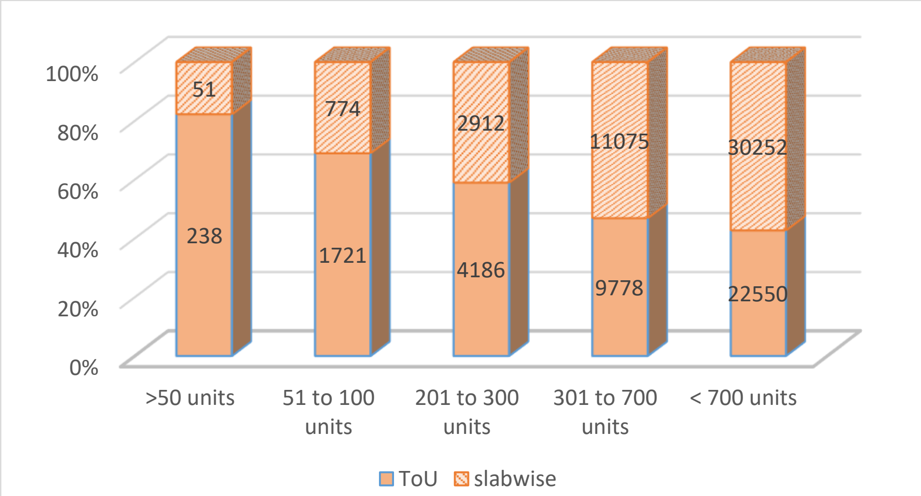
Source: Authors' illustration based on primary survey of Karachi.

Figure 17 presents the comparison of electricity unit charges with other charges of electricity which the households are bound to pay with electricity bill. These charges consist of government charges and fuel adjustment charges, imposed by the K-Electric. The figure shows that the proportion of total units' charges is highest, followed by government charges and fuel adjustment charges of electricity. Most significant information detected from this graph is that the fuel adjustment charges for the lifeline slab is more than the total amount spent on units consumed, whereas, government charges also constitute significant proportion. This information reveals that on one hand, lifeline slab is believed to be the most protected and subsidized but on the other hand, various additional charges significantly increase the total electricity bill. Conclusively, it can be depicted from the figure that households bear an extra burden in the form of these charges.

Another foremost reform in the tariff structure is the implementation of Time of Use (ToU) metering arrangement. According to this reform, all the new and existing customers having sanctioned load 5 kWh and above are installed ToU meters and are, therefore, billed on the basis of on-peak and off-peak tariff structure.

Figure 18 thus shows the electricity expenditure of households having sanctioned load greater than 5. The amount in rupees mentioned in the bars are the units consumption amount (government and other charges are not included). This figure is constructed for comparison purposes as rate of on-peak hours are charged at the highest rates irrespective of number of units consumed. In the figure, each bar is divided into two, where the solid part represents the actual expenditure of these households on the basis of ToU tariff structure. While, the textured part is constructed on the basis, if these households would be billed under slab wise tariff structure. Figure revealed that households consuming less than 300 kWh units, on average, are worsened off under this new reform. Such households are now bound to pay more than two times higher.

Figure 18: Households having Sanctioned Load 5 kWh and above



Source: Authors' illustration based on primary survey of Karachi.

Impact of Recent Increase in Tariff

Table 12 below provides the impact of recent increase in electricity tariff rates on household expenditures. Table 2 shows that by the end of year 2021 government has again revised the tariff rates for all consumption slabs except the lifeline tariff slab. For each three consumption slabs, from 1 to 300 kWh units, tariff rates are increased with flat rate of Rs. 1.61, while, for all the higher slabs tariff has been revised with a flat rate of Rs. 3.33.

Table 12: Electricity Expenditure Before and After the Tariff Increase

Slabs category	Electricity Units Expenditures (Before Tariff Increase)	Electricity Units Expenditures (After Tariff Increase)	Percentage Change
Up to 50 Units	135.35	135.35	00
Up to 100 Units	587.31	699.38	19.08
101-200 Units	1331.38	1581.60	18.79
201-300 Units	2724.99	3107.18	14.03
301-700 Units	6117.94	7022.17	14.78
Above 700 Units	21790.36	25572.70	17.36
On-Peak & Off-Peak	13201.52	15769.42	19.45

Source: Authors' calculations based on Primary data of Karachi.

In table 12 percentage increase in electricity expenditures are calculated by keeping the units consumed constant and applied new rates to calculate the expenditures after the increase in tariff. It shows that expenditures have increased more than 14 percent in all slabs. While the highest percentage increase is recorded for the households having sanctioned load of 5 or above. Impact of recent tariff revision is also substantial on lower consumption households.

Impact of Tariff Variation on Household Welfare

In this section, the study empirically explores the impact of average electricity tariff on household's welfare. The household welfare is measured by household's monthly expenditures on various commodities namely: Food & Beverages, Health, Education, Clothing, Transport, Furniture, Communication & Recreational activities. Further, the analysis is based on OLS regression model, given in equation 14, using primary data of Karachi, consisting of a sample of 467 households. Regression results are mentioned in table 13.

Table 13: Impact of Tariff on Household Expenditure

Expenditure Item	Electricity Tariff
Food & Beverages	- 0.005***
Health	-0.004
Education	0.002
Clothing	-0.005**
Transport	- 0.006***
Recreational Activities	-0.009*
Furniture	0.002
Communication	-0.005**

Note: *** indicates significant at 1%, ** at 5% & * at 10%

Source: Authors' calculations based on primary survey of Karachi.

Table 13 reports the estimates of electricity tariff, resulting from determinants of the log of household's monthly expenditures[8]. The estimates show that the impact of tariff has reduced household's welfare, measured in terms of reduction in expenditures on other commodity items, like, food & beverages, clothing, transport, recreational activities and communication. The negative and statistically significant estimate of electricity tariff on households' food expenditures reveals that one rupee increase in electricity tariff, on average, leads to decrease household's monthly food expenditures by 0.5%. Similarly, the effect of tariff increase on household's monthly expenditures of clothing, transport, communication, and recreation shows a decline of 0.5%, 0.6%, 0.9% and 0.5% respectively.

[8] Detailed and comprehensive regression results with all the covariates and income dummies are given in Annexure A7.

The empirical findings of the impact of electricity tariff on households' expenditures of other items reveal the phenomenon of crowding out effect, which can be observed from the reduction in expenditures of other items from household consumption basket as a result of tariff increase.

Energy Literacy and Behavior

Considering all the above issues in electricity management and affordability, it is now imperative to educate general public about sustainable energy consumption habits. Considering as an essential instrument, this study encompass these important modules in the recent energy survey thus to understand the cognitive and behavioral aspects of households in energy use. Including these aspects in policy design will enable individuals to make appropriate choices in energy use as well.

Various indices have thus been calculated from the literacy, behavior and satisfaction modules of the energy questionnaire. Each index is calculated by linear combinations of various indicators

Table 14: Energy Literacy Index

Town	Mean
Baldia	0.300
Bin Qasim	0.244
Gadab	0.397
Gulberg	0.325
Gulshan-e- Iqbal	0.413
Jamshed	0.455
Kaemari	0.211
Korangi	0.314
Landhi	0.260
Liaqatabad	0.461
Lyari	0.328
Malir	0.425
New Karachi	0.294
North Nazimabad	0.381
Orangi	0.167
Saddar	0.411
Site	0.210
Shah Faisal	0.382

Source: Authors' calculations based on Primary data of Karachi

Table 14 shows energy literacy index computed by employing various energy literacy indicators, given in the questionnaire. Index below measures the extent to which households' of the Karachi are energy literate. The values of index ranges from 0 (energy illiterate) to 1 (energy literate).

Table 14 shows that residents of not a single town in Karachi are literate enough about tariff structure, tariff rates and other aspects of energy. However, residents of Liaquatabad, Jamshed town, Malir town, gulshan-e-Iqbal town and Saddar town are relatively more informed.

Table 15: Energy Behavioral Index

Town	Mean
Baldia	0.375
Bin Qasim	0.05
Gadab	0.538
Gulberg	0.405
Gulshan-e- Iqbal	0.406
Jamshed	0.223
Kaemari	0.434
Korangi	0.077
Landhi	0.117
Liaqatabad	0.147
Lyari	0.500
Malir	0.675
New Karachi	0.419
North Nazimabad	0.369
Orangi	0.414
Saddar	0.342
Site	0.348
Shah Faisal	0.441

Source: Authors' calculations based on Primary data of Karachi

Table 15 shows the index that measures the households' behavior or habit for the use of electricity in their daily lives. The index value ranges from 0 to 1, where, 0 indicates households having irresponsible behavior about energy utilization and the index value of 1 indicates good habits of households.

The table shows that the households' behavior about the electricity use is moderate (indicated by dark blue colour) in Malir, Lyari and Gadab. Index values show that citizens' behavior towards energy use could be improved by educating them. This could help the policy maker in achieving the aim of efficient energy use and conservation of energy resources.

Table 16: Table 16: Satisfaction Index

Town	Mean
Baldia	0.523
Bin Qasim	0.440
Gadab	0.530
Gulberg	0.536
Gulshan-e-Iqbal	0.534
Jamshed	0.502
Kaemari	0.524
Korangi	0.538
Landhi	0.533
Liaqatabad	0.484
Lyari	0.423
Malir	0.477
New Karachi	0.500
North Nazimabad	0.512
Orangi	0.434
Saddar	0.518
Site	0.559
Shah Faisal	0.515

Source: Authors' calculations based on Primary data of Karachi

Table 16 shows the satisfaction index that measures households' level of satisfaction with K-Electric services. The index is measured using indicators based on power outages given in the questionnaire. The average value of index for each town ranges from 0 (extremely unsatisfied) to 1 (totally satisfied). Darker shade in the table shows relatively higher level of satisfaction compared to lighter shade that represents lower levels of satisfaction. Index value for each town is around 0.5 that shows the moderate level of satisfaction across households.

CONCLUSION AND POLICY IMPLICATION

From the past few years, the Government of Pakistan has initiated electricity tariff reforms that directly impact the household welfare of the country. As a result of these reforms, the government has started curtailing the electricity subsidies, gradually increasing end-consumer electricity prices. However, changing the policy to raise the subsidized electricity tariff decreases the affordability of a consumer and impacts the overall welfare of a household, thus believed to increase the energy poverty in Pakistan.

This study thus aims to analyze the impact of a rise in electricity tariffs on the welfare of households. The foremost analysis of the study is divided into three broader objectives. The first objective attempts to find the crowding-out effect of increased electricity tariffs on households' budgetary allocation of resources at various income levels. In the second section, the study endeavours to find the proportion of households dragged below the poverty line because of the rise in electricity prices. The study also measures the compensation required by the households, thus mitigating the income effect of rising electricity tariffs on households' welfare. The first and second parts of the analysis are based on HIES datasets. However, because of limitations in using secondary datasets, the study conducted a primary survey of Karachi city as a case study for obtaining in-depth information on the energy situation.

The conditional demand function was estimated to achieve the study's first objective. Results of this section show statistically significant differences in expenditure allocations for most of the expenditure categories between low and high tariff periods. It has been found that after an increase in tariff, low-income households, on average, allocated less budget for health, transport, communication, recreation, education, housing & fuel. A more or less similar pattern is observed for middle-income households. This shows that purchasing power of consumers has been depleted over the years. As far as the crowding-out effect of electricity expenditure is concerned, a heterogeneous effect for various income groups is revealed. An increase in the outlay of electricity leads to the fall in budget shares devoted to food, tobacco, recreation and restaurant for low-income households. The crowding-out effects of electricity expenditure on middle-income households are the most significant. This section shows how frequent tariff increases in the energy sector might burden limited household resources and impede prosperity.

Results of the second section show that the proportion of the population below the energy poverty threshold in 2015-16 was decreased in 2018-19, despite the increase in tariff. Around 38% of the population in Karachi city is below the international poverty threshold of $ 1.25 per day per adult. It is found that if the compensation (equivalent to the rise in electricity price) had been provided to the poor households, the poverty estimates would be declined, and about 4.7 per cent of the poor population would be pulled above the international poverty threshold. These estimates, however, indicate the impact of electricity tariff increase in inflating income poverty in Karachi city on the one hand while describing the significance of compensatory mechanism in reducing poverty on the other.

To safeguard the poorest, it is recommended to estimate social impacts on a regular basis before the scheduled price hike, thus providing targeted financial and social support programs. In this regard, existing programs like BISP or EHSAS support programs could be scaled up, or new ones could also be initiated for ensuring food security and other necessities of life, like, health care, clothing, education etc. It has also been learned from the experience of other countries that successful implementation of reforms was accompanied by compensation packages for poor and increased service quality and reliability for households paying higher prices.

As mentioned earlier, a primary survey titled "Karachi: The City of Light" has been conducted for this study. This section provided descriptive analysis on consumption, expenditure and change in the recent increase in electricity tariff on household welfare. The first important conclusion drawn from this section is that the government charges and other charges like TVL fees, fuel adjustment charges etc., constitute a significant proportion of total electricity bills. Secondly, the fuel adjustment charges for the lifeline slab is more than the total amount spent on units consumed, whereas government charges also constitute a significant proportion. Results reveal that households bear an extra burden in the form of these charges. The third important finding is related to the households having sanctioned load 5 kWh or above. It was found that households consuming less than 300 kWh units, on average, are worsened off under the ToU tariff structure. This finding shows that although electricity charges are still subsidized for low consumption households, proportion of additional costs should also be curtailed to diminish the adverse effects on the poor.

The empirical estimation from primary data substantiated the earlier section's findings that the tariff's impact has reduced household welfare. An increase in electricity tariff reduces the households' expenditures on other commodity items, like, food & beverages, clothing, transport, recreational activities and communication.

This study considers that educating the general public about sustainable energy consumption habits is imperative. Considering this as an essential instrument, this study encompasses these crucial modules in the recent energy survey, thus understanding households' cognitive and behavioural aspects in energy use. Including these aspects in policy design will enable individuals to make appropriate choices in energy use. Results show that the general public of Karachi is not informed about the current electricity sector reforms. Similarly, efficiency in end-use also needs to be improved. In this regard, literacy programs at high- school levels or through advertisements on social media could be initiated. Although, in the past, public service messages for saving electricity were communicated through television advertisements. The same policy should be continued to make individuals energy literate. Energy-efficient appliances should also be promoted to improve electricity affordability, particularly among middle and high-income households. Without any government interference, households can respond to a rise in price either by switching towards more energy-efficient appliances or adopting habits of efficient electricity utilisation. These kinds of efficiency programs would bring sustainable change in society. These measures are thus believed to provide a buffer against the adverse impact of price rise, particularly on middle and higher-income households. Existing literature for the case of Pakistan also pointed towards the importance of institutional and end-use efficiencies, like efficiency in production, distribution, and consumption.

Analysis of this study shows that the government is determined to gradually phase out electricity subsidies at a high pace in recent years. In this regard, it is recommended to publicize the upcoming rise in price among the general public as not all the individuals in the country are literate enough to anticipate the impact. However, unexpected rises in price aggravate anger among individuals and could obstruct these reform processes' smooth implementation and completion.