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Electricity Consumption Patterns: Comparative Evidence from Pakistan's Public and Private Sectors

Karim Khan,[*] Anwar Shah[**] and Jaffar Khan[***]

Abstract

This study examines the behavioral aspect of Pakistan's energy crisis by comparing electricity consumption in the public and private sectors. Specifically, we compare consumption patterns of electricity across a sample of student hostels at two public sector universities and privately run student hostels. In addition, we collect household data for a sample of students at Quaid-i-Azam University (QAU) in Islamabad and compare their average electricity consumption with that of the public sector university hostels. We find that the latter's average consumption of electricity is significantly higher than among private hostels and households. In assessing the moral hazard problem of the public sector in this context, we test the energy conservation behavior of QAU students and the university administration. The results show that students are largely indifferent to conserving electricity, while the administration pays little attention to the use of energy-efficient lights and equipment.

Keywords: Electricity consumption, public sector, private sector, moral hazard, conservation of electricity, organizational inefficiency.

JEL classification: H83, D12, D00, D03, D04.

1. Introduction

Pakistan's severe energy crisis has prevented the economy from reaching its potential in recent years. At the same time, the demand for energy is increasing continuously. For instance, from 2001 to 2008, the demand rose by almost 6 percent per annum (Kessides, 2013). This surge in demand has led to continuous growth in the gap between demand and supply over the last 30 years. In May 2012, the shortfall was estimated at 6,000 MW (National Electric Power Regulatory Authority, 2011a, 2011b).[1]

[*] Assistant Professor, Pakistan Institute of Development Economics, Islamabad
[**] Assistant Professor, Department of Economics, Quaid-i-Azam University, Islamabad.
[***] MPhil Student, Department of Economics, Quaid-i-Azam University, Islamabad.

[1] See also http://tribune.com.pk/story/154420/countrywide-energy-shortage-as-pepco-increases-loadshedding/ and http://www.theguardian.com/global-development/2012/may/29/pakistan-energy-shortfall-coal-power-plants.

This declined slightly to 4,250 MW in June 2013 with the demand for power at 16,400 MW and power generation (supply) at 12,150 MW. However, the gap is still alarming.[2] Predictions for the near future indicate that the gap between demand and supply is likely to increase to 8,000 MW by 2017 and to 13,000 MW by 2020 (Shahbaz, 2011).

The energy crisis can be studied from two perspectives: the supply side and the demand side. The supply side incorporates issues related to the production and distribution of electricity. The demand side relates to the inefficient use of electricity, which in Pakistan, is the dominant problem. According to Ullah, Khan and Akhtar (2014), 52 percent of the increase in energy intensity since 1972 was caused by the inefficient use of energy. This evidence is supplemented by the fact that Pakistan lags far behind most developed and many developing countries in terms of efficiency. For instance, for each dollar of GDP, Pakistan consumes 15 percent more energy than India and 25 percent more than the Philippines. In addition, Pakistan's energy consumption per unit of GDP is fivefold that of the average for developed countries and twice that of the world average. The potential saving from the efficient use of energy in Pakistan is estimated at 18 percent or 11.16 million tons of oil-equivalent (MTOE), which would result in a 51 percent reduction in net oil imports (Pakistan Energy Sector Taskforce, 2010).[3] All these trends imply that Pakistan has the potential to save electricity through demand-side measures, but has failed to do so thus far.

At the global level, researchers and policymakers have paid special attention to the trends and dimensions of the energy crisis, including higher energy prices, the instability in the supply of different components, rapid energy depletion and global warming. While there is substantial research on energy problems in the context of Pakistan, most studies have looked at changes in energy prices and their relation to economic growth, inflation and other macroeconomic indicators (see, for instance, Jamil & Ahmad, 2010; Javid, Javid & Awan, 2013; Shahbaz & Feridun, 2012). To our knowledge, no original work has been carried out from a micro-perspective in Pakistan. This study endeavors to initiate this angle by discussing the behavioral aspect of the demand for energy in Pakistan. In particular, we are interested in examining whether electricity consumption behavior differs between the public and private sectors and, if so, why.

[2] In 2008, the shortfall reached 4,000 MW for the first time. The Pakistan Ministry of Planning, Development and Reform (2015) reported a peak shortfall of 7,000 MW on average as of July 2014.
[3] The Pakistan Energy Sector Taskforce (2010) estimates that 6.1 MTOE (or 15.4 percent of the total energy consumed in the country) could potentially have been saved in the fiscal year 2008 alone.

In order to support our hypothesis, we have collected data on the electricity consumption of two public sector universities and a sample of private hostels and households in Islamabad. Specifically, we compare the average consumption of electricity per capita between the university hostels and the private sector hostels and households. We find a significant difference in the consumption of electricity between the two sectors. The average consumption across the public sector hostels, however, is not significantly different. Our findings support the hypothesis that public sector universities are characterized by inefficient energy use.

We examine the behavioral aspect of this inefficiency based on a survey conducted at the Quaid-i-Azam University (QAU) hostels, which documents the number of rooms left locked with electrical appliances still running. The results show that a significant number of students leave their rooms locked without having switched off the electrical appliances inside. This implies that, as consumers, students in the public sector are indifferent to the conservation of electricity. We have also collected data on the types of electrical lights used, which shows that little attention is paid to switching to energy-efficient devices at public sector universities.

Section 2 describes the literature. Sections 3 and 4 provide a theoretical background and methodology. Section 5 describes the data collected. Section 6 analyzes the results and Section 7 concludes the study.

2. A Review of the Literature

The literature on the behavioral aspect of energy consumption focuses on three strands: users' behavior at the institutional level, household behavior and the use of electricity-efficient appliances. The first strand includes considerable research asserting that the provision of free electricity in institutions makes people less likely to conserve electricity (see Siero, Bakker, Dekker & van den Burg, 1996; Scherbaum, Popovich & Finlinson, 2008; Zhang, Wang & Zhou, 2013a, 2013b, 2014).

Different factors shape such behavior. Scherbaum et al. (2008) focus on individual-level factors, but find that the public environmental consciousness is an important predictor of personal environmental norms. These, in turn, affect self-reported energy-saving behavior at the workplace.[4] In contrast, Zhang et al. (2013b, 2014) gauge the role of variables such as social and individual benefits, and the organization's

[4] Scherbaum et al. (2008) do not find any direct effect of the environmental worldview on self-reported energy-saving behavior.

own energy-saving norms. They suggest that environmental, personal and organizational benefits as well as the organization's energy conservation patterns induce employees to conserve electricity.

The second strand of the literature examines households' energy-saving behavior.[5] Abrahamse, Steg, Vlek and Rothengatter (2007) look at the effect of tailored information, tailored feedback and goal setting on energy consumption and saving behavior. They show that households that have been exposed to interventions save 5.1 percent in energy consumption compared to households in the control group, which saved only 0.7 percent. Ek and Söderholm (2010) argue that, in Sweden, providing specific information on energy saving plays an important role in energy conservation. Moreover, the willingness to save electricity differs by age group – retired people appear more willing to save than the average individual.

In a similar study, Brounen, Kok and Quigley (2013) examine the role of awareness and energy literacy in the behavior of Dutch households. They find that households that are more aware of their energy consumption are also more efficient because they conserve and organize their energy consumption better. Gyberg and Palm (2009) show that information in the residential sector can help achieve sustainable energy systems and control excess demand for energy in people's daily lives.[6]

Other studies analyze the role of socio-demographic and economic variables. Abrahamse and Steg (2009) assert that family size and income have a significant effect on households' direct and indirect energy consumption.[7] Wang, Zhang, Yin and Zhang (2011) find that smaller expenditures, subsidized energy conservation, social norms and the experience of energy shortfalls enhance electricity-saving behavior among Chinese households. However, the discomfort caused by energy-saving activities still has a negative effect on conservation behavior.[8]

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[5] See: Barr, Gilg and Ford (2005); Lindén, Carlsson-Kanyama and Eriksson (2006); Sardianou (2007); Abrahamse, Steg, Gifford and Vlek (2009); Thøgersen and Grønhøj (2010); Martinsson, Lundqvist and Sundström (2011).

[6] Feng, Sovacool and Vu (2010) argue that economic benefits and awareness play an important role in energy conservation.

[7] Abrahamse and Steg (2009) find that, among Dutch households, socio-demographic variables are more important than psychological variables in determining energy consumption.

[8] The other control they use – similar to the level of education, income and gender – has no impact on people's willingness to reduce electricity consumption.

The third strand of the literature focuses on the use of electricity-efficient appliances (including lights, air conditioners, washing machines, refrigerators, TV sets, etc.). Guan, Mills and Zhang (1997) examine the problems and prospects of energy-efficient lighting in China. They find that lack of awareness, the cost-effectiveness of power efficiency projects, primitive manufacturing processes and strong incentives to export energy-efficient products constrain the local use of efficient lighting.

Government policies also have an impact on the adoption of energy-efficient appliances. Ma, Andrews-Speed and Zhang (2011) find that energy-efficient appliances and the government's energy efficiency polices have positive implications for energy conservation in China. Accordingly, they suggest that energy conservation can be enhanced by subsidizing and promoting the use of energy-efficient appliances. Ma, Andrews-Speed and Zhang (2013) find that households prefer comfort and convenience over energy conservation, but that this behavior can be changed through economic incentives such as charging higher prices for electricity or offering discounts on the use of energy-efficient appliances.

3. Theoretical Framework

Our starting point is the standard classification of goods shown in Table 1, which divides goods in a society into four categories. Private goods are competed for, that is, individuals can be excluded from their use. Common property resources are defined by two characteristics: it is difficult to exclude users and the use of the good by one user diminishes the benefits available to other users. Nonrival goods from which users can be readily excluded (the opposite of common property resources) are called "spite goods" because this exclusion does not enhance welfare.[9] Common property resources are similar to public goods in that user exclusion is difficult, but they are also similar to private goods in that users must compete for them. By contrast, public goods can neither exclude users nor are users compelled to compete for them.

Table 1: A taxonomy of goods

	Rival	**Nonrival**
Excludable	Private goods	Spite goods
Nonexcludable	Common property	Public goods

Source: Bowles (2006).

[9] Examples include collecting a toll on a little-used highway or charging for admission to an uncrowded museum.

In most Pakistani public sector universities, the consumption of electricity is divided into three categories of use: (i) the electricity that is used in common areas such as classrooms, libraries, laboratories and public access routes, (ii) the consumption of electricity specifically by employees in offices, and (iii) the electricity used by students in residence.

In the first category, the consumption is paid for by the university as public university fees are subsidized,[10] that is, electricity is a "public" good. This means that employees and students do not pay for the electricity they consume during working or class hours. Hence, it is likely that, in the absence of moral responsibility and the positive marginal cost of an extra unit of electricity, students and employees will be indifferent to whether their electricity consumption is efficient. Similarly, in the third case, there is the probability of moral hazard with regard to electricity consumption.

In contrast, private hostels are run for profit and, as a consequence, resident students are fully liable for the costs they incur.[11] As profit-maximizing agents, hostel owners will do their best to reduce their running costs, for instance, by monitoring the unnecessary or overuse of electricity. Moreover, the profit motive may induce them to use electricity-efficient appliances to reduce costs. All these factors will ensure the optimal consumption of electricity in private hostels. In the same way, households are fully liable for the cost of the electricity they consume. As neoclassical economic agents, they will equate their marginal cost of electricity with the marginal benefit of consumption. This is their incentive to avoid overuse and to use electricity-efficient appliances in their homes.[12]

Based on this discussion, we hypothesize that the consumption of electricity is inefficient in the public sector compared to the private sector. There are three justifications for this hypothesis. First, in the public sector, the marginal cost of using an additional unit of electricity is 0 while the marginal benefit is positive. This implies a higher level of average consumption in public sector university hostels than in private hostels and households. Second, the cost of electricity to individuals in the public sector is hidden and, therefore, we expect they will not bother to avoid using extra electricity. Third, in the public sector in Pakistan, there is no formal or informal punishment mechanism for the misuse of electricity, which significantly reduces the transaction cost associated with any misuse.

[10] Universities are financed mainly by the federal government through the Higher Education Commission.
[11] In particular, this payment must ensure that hostel owners have profit rates as an incentive.
[12] For a detailed discussion, see Stern and Gardner (1981); Stern (2000); Howard (1997).

4. Methodology

We carry out a comparative analysis of the public and private sectors by using two public sector universities – QAU in Islamabad and the University of Baluchistan in Quetta – as case studies. We have collected electricity consumption data for the university hostels, 18 private hostels in Islamabad and the households of a sample of QAU students. In comparing the data for the public sector and the private sector, we expect a significant difference in consumption patterns.

Next, we investigate the behavioral causes for this difference. In particular, we are interested in showing that users in the public sector are indifferent to the conservation of electricity. For this purpose, we conduct two types of behavioral observations. First, we survey the QAU hostels to determine how many rooms are left locked but with the lights inside switched on. We expect this to be the case for a significant number of rooms. Second, we compare the types of electrical appliances used in both sectors. Again, we expect private sector users to be more concerned about electricity-efficient appliances than public sector users.

5. Collection and Characteristics of Data

The data for the two universities' electricity consumption was obtained from their monthly bills, to access which we submitted a formal application to the relevant department at each university. We also asked for information on the number of students and staff and the types of lighting used in each block.[13] Next, we noted down the 14-digit reference number on the bill (see Table A1 in the Appendix for details) and used it to download the user's annual billing data for 2013 and 2014 from the district electrical supply company's website. For a comparative analysis, we calculated the per capita electricity consumed in units[14] (the total number of consumed units divided by the number of actual users).

As Table A1 in the Appendix shows, QAU has nine hostels, five annexes and six student residences. Collectively, these comprise 1,051 rooms, including accommodation for both men and women. QAU has

[13] We needed the number of students and staff that actually consumed electricity in each block in order to find the per capita consumption of electricity. The enumerator also counted the number of each type of light in each block.

[14] Per capita consumption of electricity can also be measured in monetary terms. However, electricity companies in Pakistan charge progressively higher rates for different units of electricity consumed, which makes the monetary measure impractical for analytical comparison. Alternatively, our measure of the per capita consumption of electricity is independent of pricing policies.

approximately 8,000 students, around 33 percent of who live in its hostels. The University of Baluchistan has around 9,500 students and 17 hostels, one of which is for women. Around 1,700 students live in these hostels, which comes to almost 18 percent of the total student population.

The second sample comprises 18 privately run hostels in Islamabad. The data collected included the 14-digit reference number obtained from each hostel owner's electricity bill, the total number of resident students, and the types and number of lights used in each case. Informal discussions revealed that these hostels are administered primarily by the owners, which implies that it is in their interest to monitor the use of electricity.

Finally, the household data on electricity consumption was collected through a questionnaire distributed among a random sample of QAU students living at the university hostels (see Appendix).[15] Among other information, they were asked to record their 14-digit electricity bill reference number and the total number of energy savers, tube-lights, bulbs, air conditioners, etc., used in their homes. Based on this information, we used the reference numbers to download each user's billing data and recorded the total number of units consumed by each household. The data represents households across 35 districts in Pakistan. Of almost 400 questionnaires distributed, only 260 were completed and returned. After accounting for those with missing information, the net number of usable questionnaires dropped to 106.

6. Empirical Evidence

The empirical findings are based on a comparison of electricity consumption across the public and private sectors, and a behavioral explanation for the differences observed.

6.1. Comparative Analysis of Public and Private Sector Consumption

Table 2 summarizes the electricity consumption data collected from the two universities and the private sector hostels and households. The average monthly consumption per student ranges from 26.41 to 104.12 units in the QAU hostels (or 26.41 and 79 if we remove the outlier). In contrast, the average monthly consumption per student ranges from 8.93 to 27.87 units in the private hostels. The level of energy consumed at

[15] The data was collected from a sample of undergraduate, graduate and doctoral students. Although the questionnaire was also distributed among the women's hostels, the response rate there was low.

the QAU hostels is significantly higher than that consumed at the private sector hostels ($p < 0.05$).[16] Both types of hostels offer a similar level of services,[17] which implies that the public sector hostels use energy less efficiently because they consume more while providing the same services. This characterizes the problem of moral hazard, where the findings indicate that students misuse or overuse electricity in the public sector.

Table 2: Comparative electricity consumption

A. Public sector

Hostel name	Average consumption per month in units	Total number of students	Average monthly consumption per student in units
QAU			
Hostel #01	9,903	265	37.37
Hostel #02	6,513	245	26.59
Hostel #03	15,863	215	73.78
Hostel #04	17,460	221	79.00
Hostel #05	26,550	255	104.12
Hostel #06	14,363	378	38.00
Hostel #07	8,407	237	35.47
Hostel #08	10,087	245	41.17
Hostel #09	10,740	247	43.48
Three annexes	11,732	249	47.12
C-43	744	19	39.15
C-44	660	19	34.74
C-45	746	20	37.29
C-46	586	19	30.82
C-47	695	19	36.58
C-48	502	19	26.41
University of Baluchistan			
Hostel blocks 1–15	45,907	1,216	37.75
Hostel block 16	8,227	289	28.47
Girls' hostel	19,373	339	57.15

Continued…

[16] This *p*-value is the corresponding value of the t-statistic of unequal means while using the monthly consumption per student as the observation. See the simple regression for statistical inference in Table 4, in which the dummy for the public sector is highly significant.

[17] In Islamabad, most private hostels offer services such as hot water in winter, cold water in summer, a fan in the room, a regular water supply and ironing facilities, etc. QAU offers the same services.

Table 2: Comparative electricity consumption (Continued...)

B. Private sector

Hostel name	Average consumption per month in units	Total number of students	Average monthly consumption per student in units
Ali	257	18	14.30
Bilal	210	10	21.04
Chughtai	177	12	14.72
Danish	1,728	62	27.87
Ehsan	197	11	17.95
Fasal	836	28	29.85
Ghazi	203	12	16.88
Haris	410	18	22.78
Idrees	353	20	17.67
Jamsheed	286	32	8.93
Kurram	1,341	52	25.78
Liaqat	681	32	21.28
Moeen	310	20	15.52
Nashaad	343	15	22.85
Owais	273	20	13.65
Perooz	477	18	26.51

C. Household data

Category	Sum of average monthly consumption	Total number of individuals in household	Average monthly consumption per person
Lowest 25%	1,962.58	263	7.46
Second lowest 25%	3,276.83	200	16.38
Second highest 25%	4,568.92	179	25.52
Highest 25%	9,316.17	286	32.57

Notes: Average monthly consumption = total annual consumption in a typical year / 12. Average monthly consumption per student = average monthly consumption of hostel / number of resident students.
Total number of households = 106, divided into four quartiles based on average monthly consumption of electricity. Average monthly consumption per person for each quartile = sum of average monthly consumption by all households in that quartile / total number of household members in that quartile.
Source: Authors' calculations.

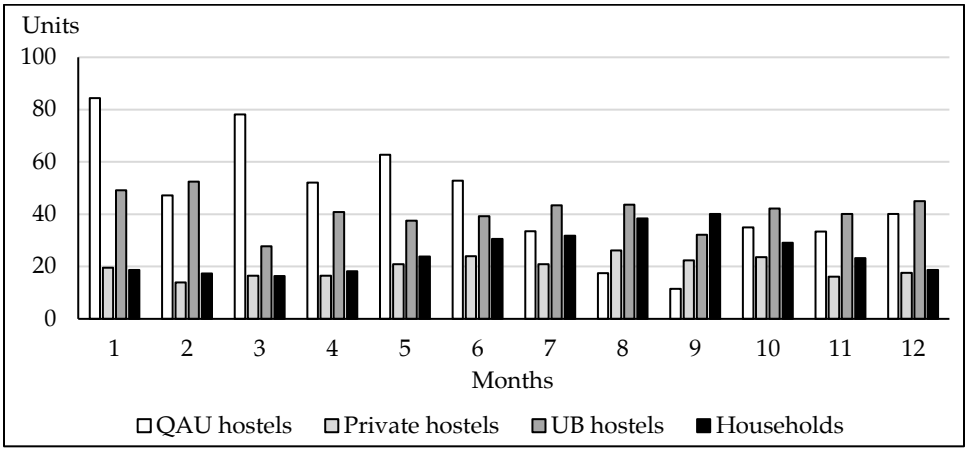
In order to check the robustness of this result, we analyze the data for another public sector university, the University of Baluchistan, and the sample of private households.[18] Table 2 shows that the average monthly consumption of electricity per student in the university's hostels

[18] The household data survey was conducted at QAU (see the questionnaire in the Appendix for details).

is not very different from that of the QAU hostels. This indicates that students' energy use behavior is similar across the two public sector universities. A comparison with the household sample shows that average consumption in the public sector is greater.

To check for the effects of outliers, we compare the average monthly consumption per person across all four types of consumers for a typical year.[19] As Figure 1 shows, in most months (except August and September), the consumption per student at QAU is greater than that of the private hostels. However, given that universities are closed in the summer, it is not suitable to compare the average consumption in these months.[20] In spite of this effect, the t-test of unequal variances shows a significant difference in the electricity consumption of the two types of hostels ($p < 0.05$). This anomaly is not robust with regard to the University of Baluchistan, where the average monthly consumption is larger than that of the private hostels all year round.

Figure 1: Comparative electricity use per student in public sector and private sector hostels



Similarly, if we compare the average consumption of electricity at QAU with the average consumption of the household sample, we find that the university consumes more energy than the households in all months except August and September. However, the households consume more electricity in the summer when the use of electrical

[19] This, in turn, allows us to counter any billing errors on the part of the electricity company or the effect of an individual hostel that may be an outlier.

[20] The regulations for running private hostels are not well enforced in Pakistan. It is possible that they are used for other purposes during the summer holidays, but we have no data to confirm this.

appliances such as exhaust fans, air conditioners and refrigerators increases. In comparison, the QAU hostels are usually closed during the summer. Again, this result is not robust with respect to the University of Baluchistan, which consumes more electricity per student than the households all year round.

The highest level of average consumption at QAU falls in January, possibly because students use nontraditional means of heating during the peak of winter.[21] However, if this is the case, it has an important behavioral policy implication: permitting students to use individual heaters or providing a centralized heating system might address the moral hazard problem of electricity consumption. The relatively low consumption per student during July, August and September reflects that the QAU hostels are closed, although this pattern does not emerge for the University of Baluchistan hostels.

We apply the Mann–Whitney U test for a paired comparison of per person consumption across all types of consumers. As Table 3 shows, QAU's average monthly consumption of electricity is significantly different from that of the private hostels and households; the same holds for average consumption at the University of Baluchistan. The average consumption of the two universities, however, is similar.

Table 3: Results of Mann–Whitney U test

Comparison	p-value
QAU hostels vs. private hostels	0.0027***
QAU hostels vs. households	0.0111**
University of Baluchistan hostels vs. private hostels	0.0000***
University of Baluchistan hostels vs. households	0.0003***
QAU hostels vs. University of Baluchistan hostels	0.6442

Note: *** $p < 0.01$ and ** $p < 0.05$.
Source: Authors' calculations.

The results imply that (i) electricity user behavior in the public sector is different from that of the private sector, and (ii) public sector organizations do not show any significant difference in their electricity use behavior. Table 4 confirms this finding, using a dummy variable for the public sector in a simple regression.

[21] University hostels in Pakistan tend not to be heated in the winters and the use of individual heaters is not allowed. However, in the absence of administrative monitoring, students often use individual heaters.

Table 4: Simple regression results

	Dependent variable = per person electricity consumption
Intercept	19.98***
Public sector dummy	24.99***
R^2	0.43

Note: *** $p < 0.01$.
Source: Authors' calculations.

6.2. Behavioral Explanation for Differences in Public and Private Sectors

This section analyzes the misuse of electricity by end-users and explains in part organizational inefficiency as far as the use of electricity-efficient appliances is concerned.

6.2.1. Misuse of Electricity in QAU Hostels

Table 5 gives the results of the survey documenting the misuse of electricity in the QAU hostels. One indicator of students' conservation behavior is whether or not they switch off the lights in their room when leaving. This is measured by the number of rooms left locked with the lights inside switched on. The survey was carried out at three different times: from 0900 to 1300, from 1400 to 1700, and from 1800 to 2100 hours. The three survey rounds were conducted on three different days.

Table 5: Misuse of electricity in QAU hostels

Hostel name	No. of rooms	First survey 0900 to 1300			Second survey 1400 to 1700			Third survey 1800 to 2100			Misuse % across three surveys
		Locked rooms	Lights on	Misuse %	Locked rooms	Lights on	Misuse %	Locked rooms	Lights on	Misuse %	
Hostel #01	105	75	57	76.00	75	63	84.00	26	17	65.38	77.84
Hostel #02	104	71	58	81.69	62	54	87.10	31	14	45.16	76.83
Hostel #03	103	56	49	87.50	76	59	77.63	27	22	81.48	81.76
Hostel #04	102	77	66	85.71	72	61	84.72	40	32	80.00	84.13
Hostel #05	116	66	54	81.82	80	61	76.25	33	21	63.64	75.98
Hostel #06	114	73	62	84.93	57	49	85.96	62	51	82.26	84.38
Hostel #07	53	43	31	72.09	29	24	82.76	31	26	83.87	78.64
Hostel #08	115	71	59	83.10	51	44	86.27	42	31	73.81	81.71
Hostel #09	115	78	67	85.90	52	42	80.77	44	35	79.55	82.76
Five annexes	100	61	47	77.05	48	37	77.08	27	19	70.37	75.74
Six C-type hostels	24	22	14	63.64	18	11	61.11	5	3	60.00	62.22
Average of all hostels				79.95			80.33			71.41	79.71

Source: Authors' calculations.

In the first two survey periods, almost 80 percent of the hostel rooms were left locked with the lights inside switched on. This decreases to around 70 percent in the third survey round, which may be because most students remain in their rooms in the evening. Hostels 1, 2 and 5 and the C-type hostels are women's hostels. We find no difference in the misuse of electricity where gender is concerned. Most students also tended to leave their fans switched on, but we did not collect data on this. Thus, students' indifference to saving electricity might partly explain the higher average consumption at QAU relative to the private hostels and households.

6.2.2. Organizational Inefficiency in the Selection of Electrical Equipment

In addition to consumer inefficiency, there is also organizational inefficiency in the public sector to consider. Table 6 compares the use of electricity-efficient lights across the public and private sectors.

Table 6: Comparative use of efficient lighting appliances in public and private sectors

Lighting appliance	QAU hostels		Private hostels		Households	
	No.	As % of total	No.	As % of total	No.	As % of total
Tube-lights	17,369	95.6	72	7.8	508	25.1
Bulbs	519	2.9	10	1.0	212	10.5
Energy savers	280	1.5	831	91.0	1,302	64.4
Total	18,168	100.0	913	100.0	2,022	100.0

Source: Authors' calculations.

Clearly, there is a considerable difference in the use of energy-efficient appliances in the two sectors. The private sector uses relatively more energy-efficient appliances than the public sector. Out of a total of 18,168 large and small lights installed at QAU, the number of tube-lights is 17,369 (95.6 percent), the number of bulbs is 519 (2.85 percent) and the number of energy savers is merely 280 (1.54 percent). In comparison, the percentage of energy savers installed in the private hostels and households is 91 and 64.4 percent, respectively. This shows that using energy-efficient appliances is still a low priority in the public sector compared to the private sector; it also reflects QAU's organizational inefficiency in this context.

7. Conclusion

This study was motivated by the literature on the moral hazard and "free rider" problems associated with public goods.

Based on this argument, we compare the consumption patterns of electricity across the public and private sectors, using a sample of public sector university hostels and privately run hostels to represent the two sectors. We also conduct a short survey to compare the average energy consumption of public sector hostels and households. Finally, we analyze the behavioral causes of the inefficiency that emerges – both on the part of users and the university administration – in the public sector.

There are three main findings of this study. First, the average consumption of electricity per capita in the public sector is significantly higher than in the private sector, including both the private hostels and households. This result is robust with respect to different organizations in the public sector (QAU and the University of Baluchistan). This has an important policy implication, given Pakistan's energy crisis. In order to offset the rising demand for electricity through conservation, policymakers must focus on the public sector. A twofold strategy is needed to enhance organizational efficiency in terms of monitoring the use of electricity, and addressing consumer behavior by developing norms that discourage the misuse of electricity. Employing both formal and informal institutional structures can help control the moral hazard associated with the misuse of electricity in the public sector.

Second, the survey finding that almost 80 percent of hostel rooms at QAU are left locked with the lights inside switched on implies considerable indifference to energy conservation among students. We recommend devising an efficient monitoring and punishment mechanism to discourage this consumption behavior at public sector institutions.

Finally, we find that the use of energy-efficient lighting in the public sector is a negligible 1.54 percent relative to 91 percent in private hostels and over 64 percent in the households sampled. This implies that the organizational structure at public sector institutions is significantly inefficient with regard to the use of energy savers. Expanding the scale at which energy-efficient appliances are used in this sector would help conserve electricity. However, future research is needed in this area to provide clear guidelines for overcoming the energy crisis.

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Appendix

Table A1: Hostel reference numbers and addresses

Public sector hostels	**Reference no.**
QAU	
Hostel #01	27-14131-0215600
Hostel #02	27-14131-0215700
Hostel #03	27-14131-0214200
Hostel #04	27-14131-0214300
Hostel #05	27-14131-0214500
Hostel #06	27-14131-0052540
Hostel #07	27-14131-0052541
Hostel #08	27-14131-0052542
Hostel #09	27-14131-0052543
Women's annex	27-14131-0119431
Men's annex	27-14131-0214400
Women's annex H-5	27-14131-0214401
C-43 (women's hostel)	02-14131-0304400
C-44 (women's hostel)	02-14131-0304300
C-45 (women's hostel)	02-14131-0304200
C-46 (women's hostel)	02-14131-0304100
C-47 (women's hostel)	02-14131-0304000
C-48 (women's hostel)	02-14131-0304500
University of Baluchistan	
Hostel blocks 1–15	24481120977600
Hostel block 16	24481140658800
Women's hostel	24481120977700

Private sector hostels	Reference no.
Main Murree Road, Barakho, Islamabad	
Ali	10-14131-3382100
Bilal	10-14131-3472700
Chughtai	10-14131-3472400
Danish	12-14131-3917300
Ehsan	10-14131-3472500
Fasal	12-14131-3912800
Ghazi	10-14131-3472501
Haris	10-14131-3471800
Idrees	10-14131-3470300
Sector F-6, Islamabad	
Jamsheed	14-14111-3167900
Chatta Bakhtawar, Chak Shahzad, Islamabad	
Kurram	09-14119-3606300
Liaqat	09-14119-3606200
Moeen	09-14119-3608600
Nashaad	09-14119-3607800
Owais	09-14119-4008600
Perooz	09-14119-4009000

Survey questionnaire

Dear respondent,

Assalam-o-Alaikum,

This questionnaire aims to collect information on the electricity consumption of households. You are requested to spare the time to answer all the questions below to the best of your knowledge. Your cooperation will enable us to explore various dimensions of the current electricity crisis. The data will be used for research at the MPhil level at the School of Economics at Quaid-i-Azam University, Islamabad.

Thank you in advance for your cooperation.

MPhil scholar

Personal information

Age:

Level of education: MPhil/PhD/MSc/BA/FSc/matric/below matric

Gender: Male/female

District:

Household information

Family structure: Joint/nuclear

Where do you live? Official house/own house/rented/other

Total number of family members:

Below 10 years:

Between 10 and 18 years:

Above 18 years:

Total number of males:

Total number of females:

House constructed:

1 year ago/2 years ago/5 years ago/10 years ago/more than 10 years ago

Total number of rooms:

Total number of energy savers:

Total number of tube-lights:

Total number of bulbs:

Total number of air-conditioners (if any):

Does your family receive an electricity bill regularly? Yes/no

Please write down the 14-digit reference number of the electricity bill:

Please tick the relevant answer to the following questions:

My family is aware of energy-saving appliances.

Yes/no/don't know

My family members turn off the lights when there is bright sunlight.

Yes/no/don't know

All my family members know that conserving electricity decreases expenditure.

Yes/no/don't know

The elders in my family encourage electricity saving.

Yes/no/don't know

Do you think students conserve electricity at QAU in the same way they would at home?

Yes/no/don't know