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# An Empirical Analysis of Electricity Demand in Pakistan

**Noel Alter**
Department of Economics, Forman Christian College,
(A Chartered University Lahore Pakistan).
E-mail: noeljee87@yahoo.com

**Shabib Haider Syed**
Associate Professor and Chairman
Department of Economics, Forman Christian College,
(A Chartered University Lahore Pakistan).
Email: shabibhaidersyed@fccollege.edu.pk

**ABSTRACT:** Study utilizes cointegration and vector error correction analysis to determination the long and short run dynamics between electricity demand and its determinants. Study uses time series data for Pakistan from 1970 to 2010. Johansen cointegration test indicate that variables integrate in the long run. Error correction term reflects the convergence of variables towards equilibrium. Electricity acts as a necessity in short run and luxury in long run. Study concludes that effective price and income policies, group pricing policy and peak-load pricing policy should be exercised for electricity demand management.

**Keywords:** Electricity Intensity, Peak-load Pricing, Derived demand, Pakistan
**JEL Classifications:** Q400, Q410

## 1. INTRODUCTION

Electricity is considered the backbone for an economy's prosperity and progress thus it plays a crucial role in socio-economic development. With the passage of time as rapid development and technological innovation has taken place the utilization of energy resources has also mounted. Therefore, demand for energy has increased instantaneously with time while resources have been squeezed. Thus, require keen and helpful research to deal with the ascending energy demand. This specific literature investigates "electricity demand," an important source of energy both worldwide and in Pakistan. In Pakistan, electricity is among the most used energy resources. Electricity is used for various purposes at residential, industrial, commercial, and agricultural sectors. Moreover, electricity in these sectors has become a necessity. In view of Khan and Qayyum (2008) in Pakistan 60 to 70 percent of the population has access to electricity consumption. They are connected to the nation's electricity grid; it indicates that as more and more electrification will occur demand will increase, requiring proper planning in the field of electricity demand management. It is also a fact that price distortion in different sectors and more use of electrical appliances boosts the consumption level of electricity.

Currently Pakistan is going through the worst energy and electricity crisis of its history. Electricity shortfall has increased about 5000 Mw, load shedding has increased from 8 to 14 hours daily, industrial growth has declined, and ultimately the whole economy has suffered. Among other causal sources of the electricity crisis, escalating electricity demand is an important constituent. Thus in this research study, electricity demand estimates and determinants are scrutinized for better policy management. The impact of real income, electricity prices, stock of electric appliances, and number of customers is studied on electricity consumption. Current electricity crises are also discussed in this study; its causes, influences and impacts. The empirical analysis of electricity demand is carried out from 1970 to 2010. The main purpose of this research study is to estimate electricity demand function of Pakistan at aggregate and disaggregate levels. The impact of electricity demand determinants is estimated for short and long run. Current energy crisis is also discussed in this study. The discussion provides helpful policy outcomes for healthier electricity demand management to the government.

## 2. LITERATURE REVIEW

Electricity demand is regarded as practical implication and analysis of demand function and is a burning concern for the last few decades due to the complications in its estimation, validity, and large fluctuations. Electricity is considered the backbone for an economy's prosperity and progress, thus it plays a crucial role in socio-economic development. It is not wrong if we say that electricity is an engine of growth at both the domestic and the global level. Increasing demand has raised the importance of research in the electricity sector. On the other hand, scarcity of electricity resources also signifies a keen scrutiny of electricity demand policies. The International Energy Agency has predicted that developing countries will increase their share of global electricity consumption from 20.5 percent in 1999 to 35.8 percent in 2020 (IEA, 2002). Thus, it becomes necessary to address the issue regarding electricity demand.

Previous studies about electricity demand have fortified the importance of electricity for the advancement and development of an economy. Where, Ghosh (2002) centralizes the importance of electricity as it is a vital infrastructural input for socio-economic development and the effectiveness and significance of electricity is manifest for every individual in these days as also mentioned by Ghader et al. (2006). Filippini and Pachauri (2004) explain that booming trend in industrialization, population growth, income growth, modernization, and urbanization are responsible for enhancing electricity consumption in the past and will increase more in the future, requiring high investment to cope with flourishing demand in the electricity sector. Filippini and Pachauri (2004) also justify the role of demand side management under limited supply of electricity. Time has proven that economic propagation, promotion, and sustainability require substantial exploitation of energy and electricity resources to stabilize the mounting demand and development (Filippini and Pachauri, 2004). Electricity is highly elastic to economic growth and development, thus requiring intense and ardent interest in economic literature (Abosedra et al., 2009).

Electricity has an important role to play in economic development and growth. For the determination of linkage between electricity consumption and economic growth, Electricity Intensity ratio (electricity consumption/GDP) is used. It reflects the extent and divergence of electricity usage in different countries. Al-Faris (2002) explicates electricity intensity ratio (electricity consumption/GDP) as an important indicator, where large value of this ratio predicts peaking electricity consumption growth as compared to GDP growth. In his scrutiny, De Vita et al. (2006) elaborates that the concept of electricity intensity implies causality between electricity consumption and economic growth (GDP) and have a critical impact as policies are concerns. Since under bidirectional association electricity consumption controlling policy may hamper economic growth and vise versa.

For theoretically basis, many studies have considered electricity demand function as derived demand depending upon household and firm's production theory. Filippini and Pachauri (2004) elaborate production theory that economic agent uses input factors to produce output. According to Narayan et al. (2007) to produce a unit of product economic agent need input factor in the form of electricity thus electricity demand adds to production function. Similarly, studies of Babatunde and Shuaibu (2008) and Vete (2005) have developed their theoretical electricity demand model by using household production theory. Based on stated theoretical background different economists have developed diverse models like; Erkan (2007) explains two models "reduced form model" and "structural form model" for electricity demand function. Reduced form model represents direct linear association of electricity demand with its determinants. This specific research study utilizes reduced form model. Reduced form model also called as double-log linear demand model. On the other hand "structural form model" is a disaggregate model where electricity demand model is represented as group of equations thus called indirect demand function. For estimation Erkan (2007) has used dynamic form of reduced model called partial adjustment model that is also used in the prior study of Berndt and Samaniego (1984). For theoretical model Beenstock et al. (1999) discusses nested and non-nested models. Beenstock et al. (1999) explains nested model on the idea that the consumer allocate resources for the consumption of competing goods after deciding total consumption allocations thus reflecting derived demand". Non-nested model tell about the simultaneous decision of the consumer for all consumption goods reflecting direct demand. In his study Beenstock et al. (1999) has preferred nested model. Ghader et al. (2006) applied derived demand function, which represents demand function as a system of equations. According to Filippini (1999), electricity demand is derived demand, which can be specified through Production theory "implies that economic agent needs input factors for the process of production," which comes in the cost and utility function of the economic agent. Halvorsen (1976) comes to the view that in the household's utility function, electricity demand appears as direct demand. Wilder and Willenborg (1975) elaborated that household's electricity demand is a derived demand as it depends on primary demand of electric stock (appliances, electric services and on other electric devices). In view of Anderson (1973) household's electricity demand is derived demand from its utility function. In addition to income and cost of commodity it also accounts for geographical, demographical and social behavior of the household. Reiss and White (2005) terminate that household's electricity is derived demand as it depends upon the stock of electric appliances whose durability determines the short and long run demand thus used utility maximization theory of household. Based upon the theoretically reviewed literature it can be stated that electricity demand is derived demand in its nature so reduced form model is useful to be implied.

Now moving forward and talking about the empirical work done in the field of electricity demand literature. For the empirical investigation of electricity demand function some of the key studies are considered. Empirical literature illuminates that in the field of electricity demand, great diversity exists regarding electricity demand determinants, demand model specification, estimation techniques, and even in results. As elaborated by Espey and Espey (2004) that economic literature regarding electricity demand reflects great diversification in economic theory, estimation techniques, model specification, nature of data and results, e.g. price elasticity of electricity demand varies from -0.076 to -2.01 in short run while -0.07 to -2.5 in long run. It is clear that in addition to economic (income, prices and appliances) variables socioeconomic, demographic, geographic and meteorological factors play crucial role in electricity demand determination. But it is also impracticable to cover all the deterministic aspects due to the lack of knowledge and data accessibility. Estimation considers wide range of techniques that are applied but still, most of the researches have used cointegration and ECM approaches via VAR model for estimation of long run relation, short run dynamics, and elasticities due to the nature of electricity data. Also that stated econometric technique give reliability and statistical plausibility of the results. Thus, before applying any estimation technique, the nature of the data should be considered.

In this particular study our focus is on the empirical analysis of electricity demand in Pakistan so literature regarding Pakistan's electricity sectors and demand becomes obligatory to be explored. International studies elaborating importance of versatile results depending upon country and region. The rapid developments and technological innovations have facilitated vast use of appliances resulting in greater energy consumption (electricity, oil, gas etc) on a large scale. Specifically about Pakistan, gas is the largest source of energy supply in Pakistan accounts for a 44 percent share, [Pakistan Economic Survey 2009-10]. Due to extensive assortment of electricity in residential (42 percent), industrial (24 percent) and commercial (7 percent) sectors it has became a necessity in modern times (Khan and Qayyum, 2008), where usage of electricity in these sectors appear in the form of cooling, lighting, entertainment etc. For the last few years, the growth rate of electricity consumption is continuously declining as Pakistan is facing the most terrible electricity crisis. These electricity crisis are made up of electricity prices increase, high-income levels, limited supply, and poor management. However, this study only focuses demand side concerns. These crises have badly thumped socioeconomic progress and all sectors in the economy. Thus, requiring intense interest in exploring electricity demand issues to provide useful, constructive, and practical suggestions to handle and manage this electricity crisis issue, as there is paucity of literature in Pakistan regarding energy and electricity demand. However, little work has been done in recent past, which appeared to be insufficient and inadequate. Some of the key studies are revealed here.

Where, the studies of Tariq et al. (2009), Khan and Qayyum (2008), and Khan and Usman (2009) signify the role of institutional framework, research and development and strong planning for future in energy sector of developing countries due to increasing demand. According to Khan and Qayyum (2009), income, electricity prices, temperature, and number of customers appear as important determinants in electricity demand function, which is estimated through cointegration and ECM. The results of study by Khan and Qayyum (2009) explain that all variables are significant with their expected signs, in short and long run electricity demand is both income and price elastic. Price elastic electricity demands suggest that electricity is a luxury good that appears strange but Khan and Qayyum (2009) justifies their results by mentioning that most of the areas in Pakistan are rural areas and in large number of rural areas electricity is not yet utilized. According to the study of Khan and Usman (2009) electricity acts as both income and prices inelastic. They observed that income and price inelastic demand reflects electricity as a necessity, supported by the fact that now a days no one can think his/her life without electricity. This outcome is elucidated after taking annul data of Pakistan for the time span of 1972 to 2007, and estimated through Johansen cointegration and ECM through VAR framework. Both above stated studies of Khan and Qayyum (2009) and Khan and Usman (2009) give unexpected and diverse results, which conflict with each other. The study of Jamil and Ahmad (2010) analyzed the relationship between electricity consumption, electricity prices and GDP in Pakistan. Cointegration and ECM is employed for the determination of causality linkage and estimates. By using annual time series data from 1960-2008, electricity demand estimates are figured out for aggregate, residential, industrial, commercial, and agriculture sectors. Results of the study by Jamil and Ahmad (2010) explain the unidirectional causality from real income and electricity prices to electricity consumption. Results of long run elasticity recognize electricity demand as income elastic and price inelastic with expected signs and significance. While in short run majority of the sectors give both income and price inelastic electricity demand. This study provides with helpful results but mainly related to the determination of the causality linkage between electricity consumption, electricity prices, and income. While this particular piece of study aimed at the determination of the main influencing factors of electricity consumption at aggregate and disaggregate level.

Based upon the brief literature regarding Pakistan it can be concluded that electricity demand plays a crucial role in policy formulation. Thus, the importance of the demand side of the electricity sector becomes vital to be studied. After reviewing important studies on electricity demand function at both Pakistan and international level it can be derived that, there exists large diversification in estimation techniques and results. Limited research studies on electricity demand estimation of Pakistan reveals more and more exploration and investigation in this sector regarding theoretical and experimental framework. The results of different studies are unlike results and appear as obstacles in the path of sustained and unique policy formulation. Thus, this specific research study takes into account the sensitivity of this issue and intends to determine the income and price elasticities. This study figures out the important determinants of electricity demand, which plays an imperative role in electricity demand derivation and opening new paradigm for policy analysis regarding electricity demand management in Pakistan. In following Table 1, results of some of the key studies about electricity demand at aggregate and disaggregate level (residential, industrial, commercial, and agriculture sectors) are stated.

**Table 1. Summary of Some of the Studies Related to Electricity Consumption**

| Author/year | Data type/time period | Estimation technique (problem) | Variables | Results (€p, €y, €s) |
|---|---|---|---|---|
| Al-Faris (2002) | Annual time series data, (1970-97), Gulf Cooperation Council countries (GCC). | Johansen cointegration and ECM technique. | *Dependent*: electricity consumption *Independent*: real GDP, electricity prices, LPG prices | SR (€p=-0.04 to -0.18, €y=0.02 to 0.08) LR (€p=-1.09 to -2.43, €y=1.65 to 5.39) |
| Bose and Shukla (1999) | Annual time series data, (1985-94), India. | OLS (under lagged model the problem of multicollinearity and heteroscehdasticity is eliminated thus OLS gives consistent estimates). | *Dependent*: electricity consumption per capita *Independent*: real GDP per capita, electricity prices, diesel prices. | SR (€p=-0.04 to -0.65, €y=0.49 to 0.81) |
| De Vita et al. (2006) | Quarterly time series data, (1980-2002), Namibia. | Bound test approach to cointegration under ARDL framework. | *Dependent*: energy, diesel, petrol and electricity consumption *Independent*: real GDP, own fuel prices, alternative fuel prices, temperature. | LR (€p=-1.45, €y=1.30) |
| Narayan et al. (2007) | Annual Panel and time series data, (1978-2003), Group of seven ($G_7$) countries. | Panel Dynamic OLS, which consider the lag and lead characteristics of independent variable (considers the problem of heteroscehdasticity and autocorrelation under both time and cross sectional analysis). | *Dependent*: electricity consumption per capita *Independent*: real GDP per capita, electricity prices, natural gas prices. | SR (€p=-0.03 to -0.09, €y=0.13 to 0.36) LR (€p=-1.38 to -9.32, €y=1.60 to 2.02) |
| Zachariadis and Pashourtidou (2006) | Annual time series data, (1960-2004), Cyprus. | Johansen cointegration approach and VECM (under time series data variance does not remain constant and causes unit root problem). | *Dependent*: electricity consumption *Independent*: real GDP, electricity prices, temperature. | SR (€p=-0.01 to -0.03, €y=0.084 to 0.089) LR (€p=-0.29 to -0.42, €y=1.11 to 1.17) |
| Lin (2003) | Annual time series data, (1952-2001), China. | Johansen cointegration technique via VAR framework (under time series data variance does not remain constant and causes unit root problem). | *Dependent*: electricity consumption *Independent*: real GDP, electricity prices, money supply, electric intensity, population. | SR (€p=-0.18, €y=0.75) LR (€p=-0.03, €y=0.86) |
| Erkan (2007) | Quarterly time series data, (1984-2004), Turkey. | Engel Granger approach to cointegration (under time series data variance does not remain constant and causes unit root problem). | *Dependent*: electricity consumption per capita *Independent*: real GDP per capita, electricity prices. | SR (€p=-0.04, €y=0.05) LR (€p=-0.29, €y=0.42) |
| Jaunky (2006) | Annual Panel data, (1971-2002), sixteen African countries. | Panel Dynamic OLS and fully modified OLS techniques (considers the problem of heteroscehdasticity and autocorrelation under both time and cross sectional analysis). | *Dependent*: electricity consumption per capita *Independent*: real GDP per capita. | SR (€y=0.39) LR (€y=0.70 to 0.76) |
| Beenstock et al. (1999) | Quarterly time series data, (1973-1994), Israel. | OLS, Engel Granger approach to cointegration and Johansen cointegration technique are employed for comparing the consistency of the results. | *Dependent*: electricity consumption *Independent*: consumer spending, electricity prices, temperature. | LR (€p=-0.01 to -0.57, €y=0.99 to 1.27) |
| Ziramba (2008) | Annual time series data, (1978-2005), South Africa. | Bound test approach to cointegration under ARDL framework. | *Dependent*: electricity consumption *Independent*: real GDP per capita, electricity prices. | SR (€p=-0.02, €y=0.30) LR (€p=-0.04, €y=0.31) |
| Abosedra et al (2009) | Monthly time series | OLS, ARIMA and | *Dependent*: electricity | LR (€y=0.20) |

| | | | | |
|---|---|---|---|---|
| | data, (1995-2005), Lebanon | exponential smoothing technique accounts for heteroscehdasticity problem. | consumption *Independent*: real imports (income), relative humidity, degree-days. | |
| Tariq et al. (2009) | Annual time series data, (1979-2006), Pakistan. | Johansen cointegration technique and ECM through ARDL framework (under time series data variance does not remain constant and causes unit root problem). | *Dependent*: electricity consumption *Independent*: real GDP, electricity prices, customers, temperature. | SR (€p=-0.63, €y=1.05) LR (€p=-0.77, €y=1.29) |
| Khan and Qayyum (2008) | Annual time series data, (1972-2007), Pakistan. | Johansen cointegration technique and ECM via ARDL (under time series data variance does not remain constant and causes unit root problem). | *Dependent*: electricity consumption *Independent*: real GDP, electricity prices. | SR (€p=-0.14 to -0.29, €y=0.44 to 1.09) LR (€p=-0.25 to -1.64, €y=0.92 to 4.72) |
| Jamil and Ahmad (2010) | Annual time series data, (1960-2008), Pakistan | Johansen cointegration technique, ECM and Causality test (cointegration analysis is preferred to avoid spurious regression). | *Dependent*: electricity consumption *Independent*: real GDP, electricity prices. | SR (€p=-0.13 to -1.19, €y=0.02 to 1.91) LR (€p=-0.76 to -2.00, €y=1.42 to 2.42) |
| Chaudhry (2010) | Annual Panel data, (1998-2008), 63 countries. | Fixed effect model (to scrutinize the income and price elasticities for Pakistan as fixed effect model facilitates to analyze the individual country under panel data). | *Dependent*: electricity consumption *Independent*: real GDP, electricity prices. | LR (€p=-0.32 to -0.91, €y=1.28 to 0.69) |

Note: €p, €y represents long run own price and income elasticities while SR and LR indicates short and long run.

## 3. ELECTRICITY SECTOR OF PAKISTAN

In Pakistan electricity is regarded as the most significant and vital constituent of energy. In modern times, the use of electricity has become essential. The current generation cannot think of their lives without electricity. Similarly, for social and economic development of a nation electricity plays an endurable part. Tariq et al. (2009) states that extensive utilization of electricity in residential, industrial, and at commercial sector affirms that it is a necessity.

**Table 2. Consumption of Electricity by Different Sectors in 2009-10**

| Sectors | Percentage Share |
|---|---|
| Household | 45.5 |
| Industrial | 26.9 |
| Agriculture | 13.2 |
| Commercial | 7.6 |
| Street light (traces) | 0.7 |
| Other govt. | 6.1 |

Source: Pakistan Economic Survey (2009-10).

Table 2 represents the consumption share of different sectors in total electricity usage in 2009-10. It can be observed that percentage share of household electricity consumption is dominated over other sectors with 45.5%. While industrial share of electricity consumption is also healthier with 26.9%. In other words, it states that both household and industrial sectors collectively consume about 73% of the total electricity. Moreover, escalation of usage of electricity in these two sectors is one of the prominent rationales behind electricity demand-supply gap.

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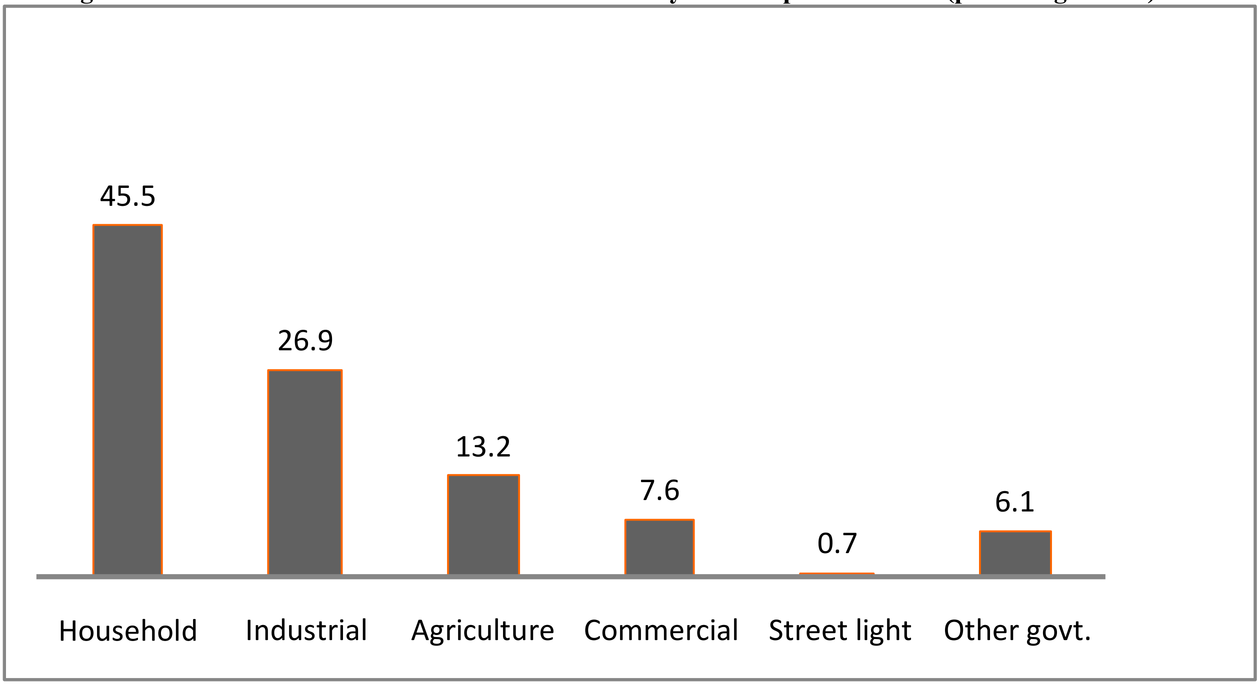
While agriculture consumes 13.2%, commercial sector consumes 7.6%, streetlight uses 0.7%, and other government sectors utilize 6.1% of the total electricity. Share of electricity consumption of different sectors is also elaborated with the help of figure 1. This vast usage of electricity in household and industrial sectors is justified by the study of Tariq et al. (2009) where he elaborated that more and more use of electric appliances e.g. air conditions, refrigerators, televisions etc in daily life require greater consumption of electricity. On other hand growth in the usage of electric appliances and technology innovations have increased the industrial production levels thus enhanced the electricity demand.

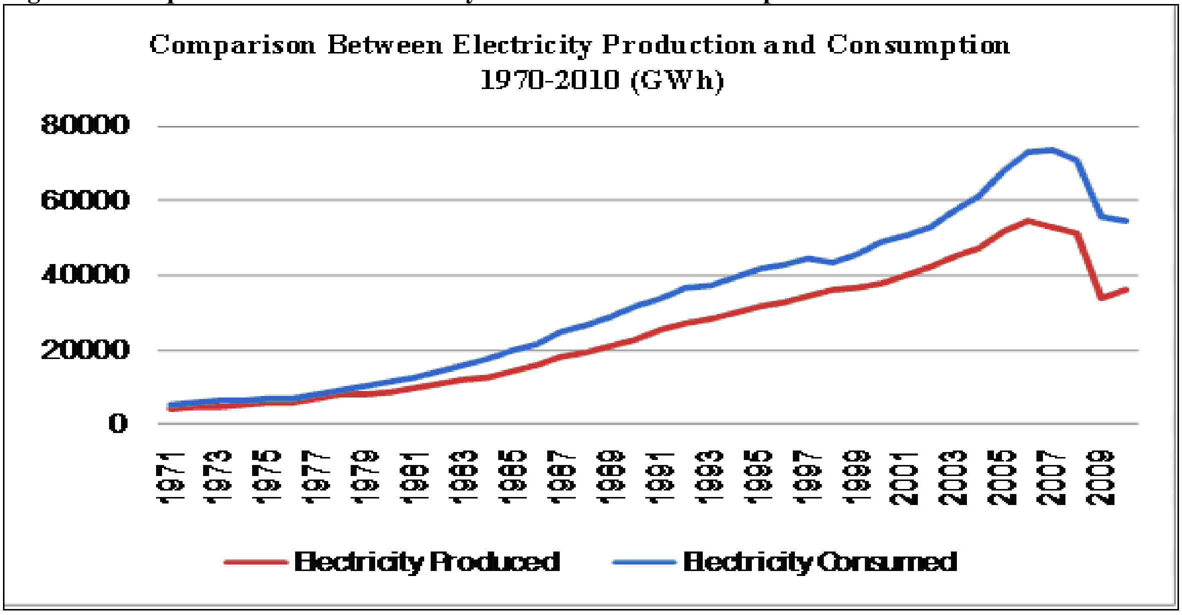
**Figure 1. Share of Different Sectors in Total Electricity Consumption 2009-10 (percentage share)**




Source: Pakistan Economic Survey (2009-10).

If we compare the electricity production and consumption levels it can easily be noticed that in Pakistan electricity production always remained short to cope the required demand. Figure 2 elaborates that right from 1980 this gap exists which widened with the passage of time and expanded further until 2010. It is clear that from 1980s electricity production and consumption gap has never closed. In 2008, this gap reached its maximum verge because of current prolonging energy and electricity crises. Khan and Qayyum (2008) justified this widening gap through peaking electricity demand and rising power shortages/losses. If we talk about the system or power (electricity) losses it can easily be witnessed from *Pakistan Economics Survey* (various issues) and *Pakistan Energy Yearbook* (various issues) that power losses are increasing where they have reached to 25% in 2010 from 15% in 1970s as the percentage share of total electricity generation. The reason behind these peaking electricity losses are mentioned by Khan and Qayyum (2008), as awful management, corruption and weakness of policy implementation authorities.

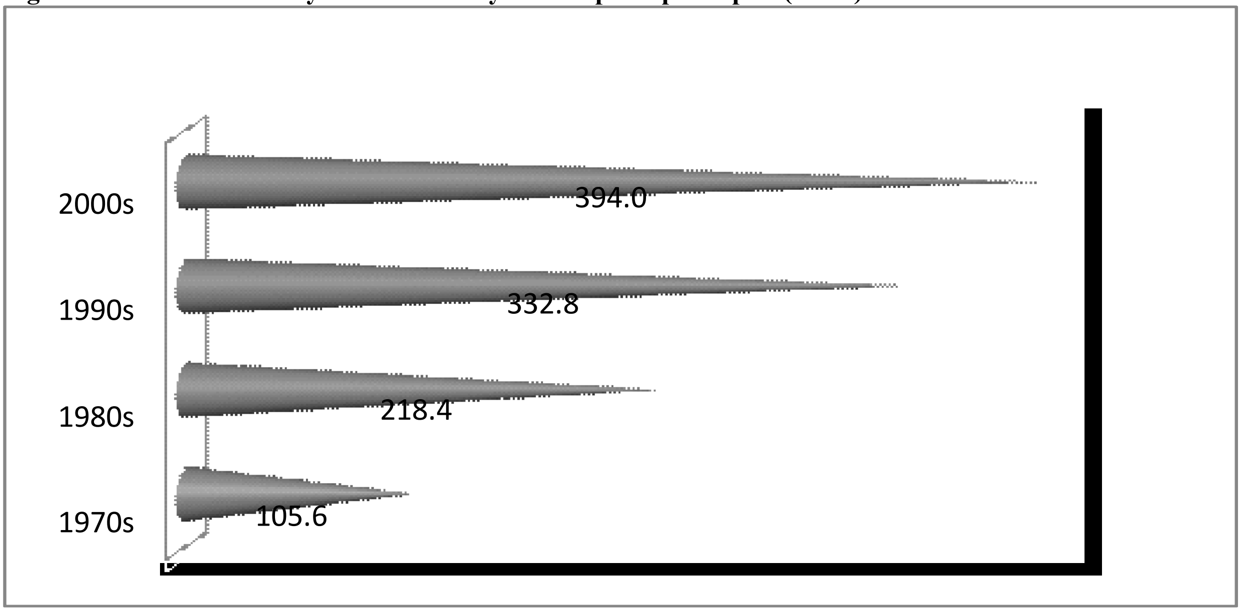
**Figure 2. Comparison between Electricity Production and Consumption**




Source: Computed from Pakistan Economic Survey (various issues).

By looking at the historical background of electricity sector of Pakistan it can be seen that Pakistan's electricity sector has seen rapid progress. In 1947 Pakistan's electricity generation capacity was only 60MWh for 31.5 million populations, which reached to 64,747Gwh in 2010 to facilitating over 16 billion people. Total electricity generation is facilitated through thermal, hydro, and nuclear resources having share of 65%, 33.5% and 1.5% respectively (Pakistan Economic Survey 2009-10). By looking at the per capita electricity consumption, it is clear that per capita electricity consumption is increasing since 1970s where it has reached to its highest verge of 394kw per annum in 2000s, as elaborated in figure (3).

**Figure 3. Decade vise Analysis of Electricity consumption per capita (KWh)**




Source: Computed from Pakistan Economic Survey (various issues).

No doubt, Pakistan's electricity generation capacity has increased but still it is unable to manage with mounting demand. This is expected to rise further in future due to electrification programs. As according to *Pakistan Energy Yearbook (2008),* still 20-25% area of Pakistan is not linked to national electric grid. This rising electricity demand indicates that with economic growth, utilization of electric energy and sources is necessary in both industrial and non-industrial sectors. This association between electricity consumption and economic growth is known as *"electricity intensity"*; it explains and compares the rates of electricity growth and economic growth. The unit value of electricity intensity ratio indicates that both economic growth and electricity growth are moving with the same speed, while higher value of this ratio illuminates greater growth rate of electricity with comparative to economic growth and vise versa. Electricity intensity statistics can be analyzed through table 3, where electricity intensity ratio is provided from 1970 to 2010 in aggregated values. For more scrutiny of this ratio data is taken into its average value for every five years.

**Table 3. Electricity Intensity Ratio (KWh/Rs)**

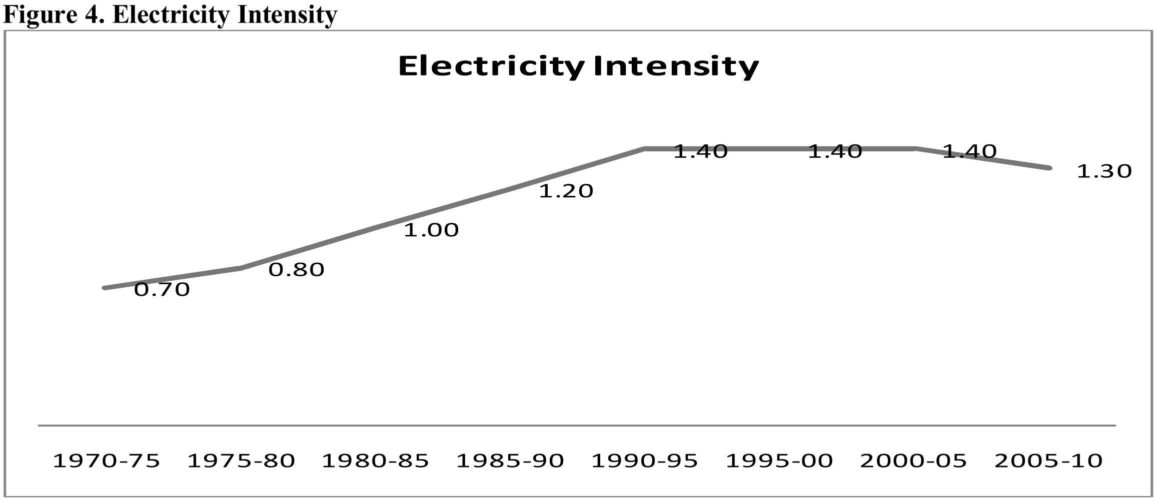
| Years | Electricity Intensity (Electricity Consumption/ Real GDP) |
|---|---|
| 1970-75 | 0.70 |
| 1975-80 | 0.80 |
| 1980-85 | 1.00 |
| 1985-90 | 1.20 |
| 1990-95 | 1.40 |
| 1995-00 | 1.40 |
| 2000-05 | 1.40 |
| 2005-10 | 1.30 |

Source: Computed by the author.

Electricity intensity ratio for Pakistan can be studied in two verges. First from 1970 to 1990 where this ratio is escalating persistently and indicating that growth rate of electricity consumption is moving faster as compared to economic growth while in the second phase from 1990 to 2010 this ratio is remaining almost constant reflecting the difference between the growths of both electricity consumption and economic growth are progressing with the same rate but still growth rate of electricity consumption is greater than economic growth. Trend in the electricity intensity ratio is also revealed in figure (4), where this ratio is minimum in 1970s and reaching to its maxima in 2000s. Electricity intensity ratio has started to increase in late 1970s and early 1980s due to the fact of rapid industrialization in Pakistan and vast usage of electricity to run factories and industries.

As in 1980s, Pakistan has experienced average industrial growth rate of 9 to 10 percent annually. Thus, this peaking trend in electricity intensity indicates higher growth rate in electricity consumption compare to GDP growth rate. It is an alarming sign for electricity demand management to sustain this peaking trend. Based upon the above stated important facts, the role of energy and electricity sector cannot be overthrown for the prosperity of any economy. Better energy and electricity sector leads towards the boom of an economy. Pakistan has seen better development in energy and electricity generation but it is not enough to manage the national requirements mainly at the household and industrial level.

**Figure 4. Electricity Intensity**




Source: Computed by the author.

From the very beginning, this insufficiency in energy and electricity sector is prominent which has widened further and the demand-supply gap has reached to 20-30 percent in both electricity and energy sector. This shortfall in electricity sector has reached to 5,529MWh in 2009-10. This large deficiency appeared due to insufficient supply and massive demand for energy and electricity. As this study only focuses on demand side thus vast usage of electricity appliances, rising living standards and demand management issues are regarded as key entities for the energy and electricity demand explosion. In the last few years, the energy and electricity conditions have worsened which have shaken, tilted, and deteriorated the whole economy. The next section particularly explores these energy and electricity crisis in detail.

Currently Pakistan is tilting with the most dreadful energy and electricity crisis of its history. Where elevated electricity prices, enlarged electricity demand and persistent electricity shortage has stressed the whole economy and the country. International energy price increase has lifted the local energy and electricity prices, which have badly affected the masses in Pakistan. The government of Pakistan has started immense load shedding of about 8 to 16 hours daily, all over the country (Tariq et al. 2009). Other strategies like time augmentation for the more and more utilization of daylight has been adopted. However, all the remedial steps have gone in vain with no prolific outcome. Khan and Usman (2009) state that according to the statistics of 2009 the per day electricity demand in Pakistan is about 15000MWh while generated electricity on daily basis is about 11,500MWh. This 3500MWh shortage in 2009 and 5529MWh in 2010 (Chaudhry 2010) is affecting industrial, commercial and residential sectors badly also that this power shortage is expected to enlarge further until and unless some rapid and instant actions are not taken by the government. Ghaus (2010) affirm these energy and electricity crisis as outcome of erroneous planning; under estimating the increasing energy and electricity demand and lifting tariffs on imports of electric appliances.

Energy and electricity shocks have hampered the economic growth and development of the social sector as well. Restricted supply of energy and electricity in industry for production are appearing as a constraint for growth. It has been noticed that from 2008 the industrial production and output has considerably decreased as production level has shrinked by 6 percent (Ghaus 2010). Electricity intensive industries i.e. textile, metallic and non-metallic industries, paper industry etc are most affected. In view of Siddiqui (2004) energy and electricity prices play an important and crucial role in overall growth and development of the economy as well as its poor masses.

The disparities in the energy price setting for different sectors of Pakistan is another important issue where industrial sector which is according to Abosedra et al. (2009) the most prolific sector of any economy, is highly burdened with price. On other hand, subsidies have been provided in the agriculture sector that earns low revenue.

As we talk about the causes of the current electricity crises, it can be seen that in the last decade the demand for electricity has suddenly erupted as the study of Ghaus (2010) elaborates that growth of electricity demand has uplifted up to 7 to 10 percent per annum. The main reason behind this exceptional growth of electricity demand was more and more usage, import and production of electric appliances at domestic and industrial sectors, as statistics from *Pakistan Economic Survey* (various issue) indicates that 0.5million electric appliances were used in Pakistan in 1991 which reached an alarming figure of 7.9 million in 2009-10.

Other reasons behind high electricity consumption are industrial growth, banking and multinational company's schemes of leasing home appliances and price distortions in the electricity market (Afzal 2008). Dispension of electricity supply, development, and progression of power generating plants is always neglected. Ghaus (2010), explicate that a random downfall in the public expenditure on power generation has been observed, in 1980s expenditures of government on power generation were 28 per cent out of total expenditures on average which demised to just 3 per cent in recent years. Electricity losses and theft has also contributed to these crises to some extend where electricity theft has reached to 21,472 million KWh in 2009-10 from 2240 million KWh in 1970. Electricity theft is dangerous for any economy as it reduces the availability of electricity for the people and revenue to the power generation sector.

Energy and electricity acts as fuelling power for the whole economy in general and specifically for industrial sector. Electricity crises has consequently dwindled the revenue and production of firms. The high electricity tariffs and peaking load shedding has almost damaged the manufacturing sector. The growth rate of industrial and manufacturing sector has turned negative -1.9

and -3.7 respectively in 2008-9 (Pakistan Economic Survey 2009-10). According to a survey of Institute of Public Policy (IPP), Beacon House University (BHU, 2010) industrial sector of Pakistan faces average 4.6 hours load shedding at its peak working hours every day and this duration further increases in summer season.

Moreover, industrial production has decreased by 7% with value added loss of 42 billion rupees and employment loss of 300,000 people in 2008-09 (IPP, BHU 2010). These outages of electricity have distressed the industrial sector which according to Siddiqui (2004) and Ghaus (2010) have multiplier consequence on the economy. Because of bad performance of the industrial sector due to electricity crisis, the GDP growth of the economy has fallen by 2 per cent, with 400,000 employment losses and 75 billion rupees loss of exports in 2008-09 (Ghaus 2010). Industrial growth rate in last five years has decreased to 2.4% on average and export growth has demised to 1.2% in last few years and mainly constituted by current electricity shocks.

All above stated facts elaborate the need of better policy and management to avoid any ruthless economy crises in Pakistan. According to Ghaus (2010) currently Pakistan is facing 210 billion rupees loss due to electricity shortage and crisis. These energy and electricity outages can be over come in future by building more dams, uniform pricing, proper demand management, theft control, and better distribution management.

In this section, it has been observed that these energy and electricity shocks are both demand and supply side consequences but this particular research will only deal with the demand aspect. In Pakistan the rising demand of electricity is a consequence of peaking production and import of the stock of electrical appliances and equipment, increasing living standard and income levels of household, industrial growth, banking and multinational company's schemes of leasing home appliances and electrification for population density. The impact of electricity prices on electricity consumption is also crucial.

Thus, this study aims to strive for consistent and reliable income, prices, electricity appliances, and population (customers) estimates for better electricity demand management policies. The role of income, electricity prices, and stock of appliance elasticities will be crucial.

## 4. RESEARCH METHODOLOGY AND DATA

Theoretically electricity demand is derived demand in its nature as it depends upon the utilization of input factors, which are used by the economic agent in production process. Thus electricity demand has firm roots in "production theory," according to which economic agents (household, firm and etc) use input equipments or stocks for the production processes. In case of electricity demand, these agents utilize electricity consumption as input factor to produce commodities that appear as derived demand and augment in the agent's utility and cost functions. Electricity demand depends upon the stock of electric goods, capital equipment, demographic, and geographic factors. The prior knowledge affirms that electric appliances, income and prices (electricity and alternative) are regarded as fluctuation forces for electricity consumption while some demographic and geographic have also significant effect depending upon the circumstances.

In this research study which specifies the empirical analysis of electricity demand in Pakistan, electricity demand is considered as sensitive to alternative fuel prices and it will not be wrong if we say that alternative fuel acts as complements of electricity. At vast area these fuels i.e. oil, gas etc are used as input factors for the generation of electricity[i]. Therefore, here demand function will not include alternative fuel prices as they do not act as a substitute for electricity in case of Pakistan. In addition to that our focus of study is on annual data thus temperature will not be incorporated as it is a seasonal phenomenon with regard to electricity consumption and out of the scope of the study. Studies, which have analyzed the impact of temperature, are mostly quarterly and high frequency data studies. This study uses annual time series data, which does not capture the seasonal impact of temperature. Also that the main objective of this study is to determine the influence of real income, prices, number of customers, and stock of electric appliances on the consumption of electricity. Consequently demand function is stated in followings:

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[i] Where proportion of gas 38%, fuel 27%, hydel 29%, nuclear 3%, coal 2% and imported 1% is utilized for the generation of electricity, Energy Year Book (2009).

**Electricity Demand function**

*Electricity demand = f (real income, electricity prices, number of consumers, electric appliance)*

For the empirical specification of electricity demand model the studies of Al-Faris (2002), Bose and Shukla (1999), Ziramba (2008), De Vita et al. (2006), Galindo (2005) and others[ii] have seized electricity demand as double log linear function of its determinants and have used "reduced form model". This double log linear specification is derived after utility maximization and cost minimization techniques. Double log linear specification of the model yields elasticities which according to Varian (1988) helps in demand management, demand behavior analysis, electricity forecasting and policy analysis.

**Electricity Demand Model**

$Elect_i = \alpha + \beta_1 rincome_i + \beta_2 prelect_i + \beta_3 Cust_i + \beta_4 App_i + \varepsilon i$ _____________ *(I)*

**Where**

*Elect = Electricity consumption/demand*
*rincome =real income*
*prelect = Electricity prices*
*App = Stock of electric appliances*
*Cust = Number of customers*
*εi = Error term*
*i= Aggregate, Residential (household), industrial, commercial and agriculture sector.*

**Double Log-Linear Specification of the Electricity Demand Model**

$logElect_i = \alpha + \beta_1 logrincome_i + \beta_2 logprelect_i + \beta_3 logCust_i + \beta_4 logApp_i + \varepsilon_i$ ___________ *(II)*

Scope of this study reflects the electricity demand estimation both at aggregate and disaggregate (household, industry, agriculture, commercial) level. Thus we will now formulize both aggregate and disaggregate electricity demand models in their logarithmic form for the sake of getting elasticities and represented by *"log."*

**Aggregated or total electricity demand model**

$logElectA = \alpha + \beta_1 logrincomeA + \beta_2 logpreleectA + \beta_3 logCustA + \beta_4 logApp + \varepsilon_{i1}$ __________ *(III)*

**Residential electricity demand model**

$logElectR = \alpha + \beta_1 logrincomeR + \beta_2 logpreleectR + \beta_3 logCustR + \beta_4 logApp + \varepsilon_{i2}$ __________ *(IV)*

**Industrial electricity demand model**

$logElectI = \alpha + \beta_1 logrincomeI + \beta_2 logpreleectI + \beta_3 logCustI + \beta_4 logApp + \varepsilon_{i3}$ ____________ *(V)*

**Commercial electricity demand model**

$logElectC = \alpha + \beta_1 logrincomeC + \beta_2 logpreleectC + \beta_3 logCustC + \beta_4 logApp + \varepsilon_{i4}$ _________ *(VI)*

**Agriculture electricity demand model**

$logElectAg = \alpha + \beta_1 logrincomeAg + \beta_2 logpreleectAg + \beta_3 logCustAg + \beta_4 logApp + \varepsilon_{i5}$ ______ *(VII)*

Following grid represents the notations of variables affirmed in the above models.

**ElectA** (Aggregate electricity consumption), **ElectR** (Residential electricity consumption), **ElectAg** (Agriculture electricity consumption), **ElectI** (Industrial electricity consumption), **ElectC** (Commercial electricity consumption), **rincomeA** (Aggregate real income), **rincomeR** (Real income of residential sector), **rincomeAg** (Real income of agriculture sector), **rincomeI** (Real income of industrial sector), **rincomeC** (Real income of commercial sector), **prelectA** (Aggregate electricity prices), **prelectR** (Residential electricity prices), **prelectAg** (Agriculture electricity prices), **prelectI** (Industrial electricity prices), **prelectC** (Commercial electricity prices), **CustA** (Total customers), **CustR** (Residential customers), **CustAg** (Agriculture customers), **CustI** (Industrial customers), **CustC** (Commercial customers), **App** (Stock of electric appliances).

In electricity demand estimation, income and prices (tariffs) are considered as most important determinants of electricity consumption. However, the importance of other variables i.e. electric appliances and number of customers cannot be overthrow. Here this section will explore the important factors affecting electricity demand, their linkage and collection sources. This study considers electricity consumption as a dependent variable. Electricity consumption plays important role for the

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[ii] Erkan (2007), Neeland (2009), Dilaver (2008), Beenstock et al. (1999), Filippini and Pachauri (2004), Filippini (1999), Wilder and Willenborg (1975), Halvorsen (1975), Anderson (1973), Khazzoom (1973), Faik (2006), Narayan et al. (2007), Clements and Madlener (1999), Tariq et al. (2009), Khan and Qayyum (2008).

well-being and development of an economy. Thus the important to electricity sector is always crucial. For the estimation of demand function, electricity consumption is utilized at both aggregated and disaggregated levels. Electricity consumption is used in million-kilowatt unit. Followings are some identified factors, which influence electricity consumption to significant extent in Pakistan.

**Income:** As far as the literature is concerned income is the most important influencing element of electricity consumption. Rise of income level enhances the purchasing power and ultimately results in increased demand. Similarly, at macro level economic growth (gross domestic product) affects living standard of individuals and hence is a main driving entity in the growth of electricity consumption. Many important studies i.e. Al-Faris (2002), Narayan et al. (2007), Jamil and Ahmad (2010) and other have used real income as key explanatory variable. Thus have significant positive linkage with electricity consumption level. For income considerations this study uses real GDP both in aggregate and sector vise. Sector's income considers contribution of household, industrial, agriculture and commercial sectors in GDP. Industrial, agriculture and commercial income levels are obtained as income contributions of these sectors in GDP while for household income level private expenditures are used. Real income is obtained after dividing income levels to GDP deflator, which will explore this association more effectively and significantly. Real income is used in million rupees.

**Electricity prices**: Second most influencing entity in electricity consumption is its prices or tariffs. Like other countries, in Pakistan these electricity tariffs are set administratively. In Pakistan electricity tariff setting has always remained sensitive and crucial due to is significant and everlasting influences on all sectors and economic affairs. In spite of this, electricity prices/tariffs are an imperative variable in the function of electricity demand due to its greater influence on electricity consumption, as lower tariff enhances growth in electricity consumption. In Pakistan homogenous electricity prices do not prevails in all sectors, the agriculture sector is the most subsidized sector and has very low prices while on other hand commercial sector is a highly tariffed sector. This study considers weighted average prices for all sectors and also at aggregated level. It is authenticated that cost of electricity differs on the basis of used units, and different customer uses different range of units. Thus to incorporate this problem weighted average is considered. For the determination of weighted average price index, firstly weight of the electricity consumption based upon the unit consumed of different sectors is multiplied by the prices of sectors. Then that product is divided by the total weight. Finally, average of all weights is deducted[iii]. Electricity prices usually have negative linkage with electricity consumption. Unit of electricity tariff is its cost in rupees per kilowatt (Rs/kw).

**Stock of Electric Appliances:** Electricity demand is derived demand and depends upon the usage of stock of the electric goods and capital stock. Thus on that basis, electric appliances appears to be an important influencing factor of electricity consumption and expresses positive linkage with it. In this study for the stock of electric appliances, the value of imported durable electric goods is used as more suitable proxy for electric appliances. Value of imported durable electric appliances is taken in million rupees.

**Customers:** Here customers are defined as the number of consumers that are using electricity for the derivation of utility. It also reflects the demographic feature of population. An increase in the number of consumer leads to the enhancing electricity consumption levels, for more individuals large number of electricity units will be needed thus constitutes positive linkage. Here in this study number of consumers is used in million numbers for each sector and at the aggregated level who are consumers of electricity.

Data of all variables is collected from various sources i.e. *Pakistan Energy Year Book* (Various Issues), *Pakistan Economic Survey* (Various Issues), *World Development Indicators* (WDI) and *Asian Development Bank* (ADB).

For econometric analysis Cointegartion technique is utilized in three steps: Firstly, Unit root test is utilized for the determination of the order of integration of the parameters. That will be done by using Augmented Dickey Fuller (ADF) and Phillip Perron (PP) tests. Secondly, Cointegration analysis is applied for the estimation and determination of stable long run equilibrium relation among parameters and to check the integration of linear combination of variables. That will be done through Johansen cointegration technique, which determines the existence of a cointegrating vector in the time series of non-stationary variables. And lastly, for the determination of short run dynamics, the Error

[iii] For the details of calculating weighted average electricity prices see Tariq et al (2009)

Correction Model is considered. Which gives speed of adjustment to long run equilibrium after fluctuation, and this speed of adjustment is calculated through Error Correction term (ECT).
Now the following section will elaborate and study the stated econometric procedures in detail.
**Unit Root Test**: Unit root test is considered as a primary test before applying cointegration. Unit root test is applied to check the stationarity (non-stationarity) and integration order of the parameters. Where Holden and Perman (2000) define time series stationarity in which mean, variance and autocovariances does not depend on time and stochastic process is said to be white noise[iv]. White noise asserts that in the time series the stochastic process is purely random and parameters are said to be stationary. Here Augmented Dickey Fuller (ADF) and Phillip Perron (PP) tests are utilized to check the integration order and stationarity at level I (0), first difference I (1) and so on. Under unit root test following equations are estimated for the testing of hypothesis.
**Testing procedure**
General equation
$\Delta N_t = \alpha_0 + \alpha_i t + \beta_i N_{t-1} + {}^{m}\sum_{i=1} \gamma_i \Delta N_{t-i} + \varepsilon_t$ __________ *(VIII)*
(i = 1,2,3,4,5, ……m)
Where $N_t$ represents any variable being tested for null hypothesis of $N_t \sim I(1)$ which becomes stationary at $\Delta N_t$, and $\Delta N_t = N_t - N_{t-1}$ "t" represents the trend while "$\varepsilon_t$" is white noise error. Here the lag length of the variable is chosen after applying Schwartz and Bayesian Criteria (SBC) information Criteria.
Here null hypothesis of non-stationarity is tested against the alternative hypothesis of stationarity.
Specifying unit root testing equation for each variable
$\Delta\, logElectA_t = \alpha_0 + \alpha_1 t + \beta_1\, logElectA_{t-1} + {}^{m}\sum_{i=1} \gamma_1 \Delta\, logElectA_{t-i} + \varepsilon_t$_______ *(IX)*
$\Delta\, logElectR_t = \alpha_0 + \alpha_2 t + \beta_2\, logElectR_{t-1} + {}^{m}\sum_{i=1} \gamma_2 \Delta\, logElectR_{t-i} + \varepsilon_t$_______ *(X)*
Similarly for each variable unit root equation will be formulated. Where $\alpha_0$ indicates the constant term, $\gamma_i$ is the coefficient of changing ($\Delta$) parameters having the lag order of the autoregressive process. After the formulization of testing equations the unit root test is carried out under the null hypothesis $\beta_i = 0$ against the alternative hypothesis of $\beta_i < 0$. (i = 1, 2, 3 …)
**Cointegartion Test:** *Definition:* The vectors are cointegrated of order (r), in case of their linear associations, and integrated of (r-d) order (Rao 1994). Then we declare that "N" vector is cointegrated: $N \approx CI\ (r, d)$
The progression "N" is cointegrated at order (r, d) having vector of cointegration $\beta \neq 0$ proviso $\beta_o^{\prime} x_t$ has integration order I(r-d), where d =1,…, r, r =1,… (Johansen 1988). After the determination of stationarity the cointegration test is utilized. In view of Engle and Granger (1987) linear combination of non-stationary series of variables might be stationary; this result comes under cointegration analysis. Cointegration is regarded as econometric equipment for time series parameters. The series of non-stationary variables is considered as cointegrated if their linear combination becomes stationary. Cointegration test verify whether linear combination of non-stationary series cointegrate or not. Here linear permutation is identified as cointegration equation.

Rao (1994) elucidates cointegration as estimation technique that considers long run equilibrium parameters having unit root variables. Cointegration is applied for the determination of long run association among set of variables and the causes of stability. Two or more variables are said to be cointegrated if solitary they contain stable long run linkage. Greene (2003) elaborates cointegration as pre-test for the avoidance of spurious regression analysis. Greene (2003) also explains that in cointegration analysis, the integration order of all variables should be same[v] and greater than I (0), means series should be non-stationary at level form.

This specific research utilizes Johansen (1988, 1990) approach to cointegration as it provides consistent results in multivariate cases. Johansen's (1988, 1990) cointegration approach is based on Vector autoregressive (VAR) model. Johansen cointegration method determines the integrating vectors among a series of variables, which distinguish it from other techniques used under cointegration analysis. In Johansen cointegration technique null hypothesis of no cointegration vectors

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[iv] $E(\varepsilon_t)= 0$, $E(\varepsilon_t^2)= \partial^2$, $Cov(\varepsilon_t, \varepsilon_s)= 0$
[v] Similar integration order applies that series drift together with same rate and might have stable association about the predetermined mean in long run.

is tested against the alternative hypothesis of cointegrating vectors. Rejection of null hypothesis leads to the confirmation of long run stable equilibrium association among variables and vise versa.
Generalized form of Johansen's cointegration equation originated through VAR specification for multivariate model can be stated as:

$$\Delta N_t = A_o + A_1 \Delta N_{t-1} + A_2 \Delta N_{t-2} + \ldots\ldots\ldots + A_p \Delta N_{t-p} + \varepsilon_t \quad (XI)$$

Where
p = Autoregressive order
A = n * n matrix of parameters ($\beta_i$) of $N_i$ variables
$\varepsilon_t$ = White noise error
Specifying Johansen cointegration equation through VAR model for each model

$$\Delta\, logElectA_t = \alpha + \beta_1\ logrincomeA_t + \beta_2\ logprelectA_t + \beta_3\ logCustA_t + \beta_4\ logApp_t + \gamma \Delta\, logElectA_{t-i} + \varepsilon i \quad (XII)$$

$$\Delta\, logElectR_t = \alpha + \beta_1\ logrincomeR_t + \beta_2\ logprelectR_t + \beta_3\ logCustR_t + \beta_4\ logApp_t + \gamma \Delta\, logElectR_{t-i} + \varepsilon i \quad (XIII)$$

$$\Delta\, logElectI_t = \alpha + \beta_1\ logrincomeI_t + \beta_2\ logprelectI_t + \beta_3\ logCustI_t + \beta_4\ logApp_t + \gamma \Delta\, logElectI_{t-i} + \varepsilon i \quad (XIV)$$

$$\Delta\, logElectC_t = \alpha + \beta_1\ logrincomeC_t + \beta_2\ logprelectC_t + \beta_3\ logCustC_t + \beta_4\ logApp_t + \gamma \Delta\, logElectC_{t-i} + \varepsilon i \quad (XV)$$

$$\Delta\, logElectAg_t = \alpha + \beta_1\ logrincomeAg_t + \beta_2\ logprelectAg_t + \beta_3\ logCustAg_t + \beta_4\ logApp_t + \gamma \Delta\, logElectAg_{t-i} + \varepsilon i \quad (XVI)$$

(i = 1, 2, 3, 4, 5,……)

$\beta_i$ refers to the cointegrating vector of parameters. Here the lag length of autoregressive process is determined by the Schwartz and Bayesian Criteria (SBC) information Criteria[vi]. Existence of cointegration relation justifies the long run association between the variables and explains that variables establish equilibrium linkage.

**Hypothesis formulation**

(Null hypothesis) $H_o$: $\beta_i = 0$ (no cointegration among variables)
(Alternative hypothesis) $H_1$: $\beta_i \neq 0$ (cointegration among variables)
Where, (i = 1, 2, 3, 4, 5)

**Vector Error Correction Model (VECM):** Uptill now we have discussed the long run equilibrium relationship between the variables now we will talk about the stability of that long run association, facilitated through VECM. VECM explicates the short run dynamics and speed of adjustment of integrating variables after fluctuations in short run. In Error Correction Model movement towards long run equilibrium is obtained through pervious period's error $u_{t-1}$.

**General form of VECM**

$$N_t = \beta Z + v_i + \varepsilon t_i \quad (XVII)$$

Where Z is vector of independent variables, $v_i$ represents the equilibrium error and $\varepsilon t_i$ is white noise error.
Now specifying VECM for each electricity demand equation in six variable cases

$$\Delta\, logElect_t = \alpha_1 + {}^{j}\textstyle\sum_{i=1} \pi_{1i} \Delta\, logElect_{t-i} + {}^{k}\sum_{i=1} \beta_{1i} \Delta\, logrincome_{t-i} + {}^{m}\sum_{i=1} б_{1i} \Delta\, logprelect_{t-i} + {}^{n}\sum_{i=1} \rho_{1i} \Delta\, logApp_{t-i} + {}^{p}\sum_{j=1} \varphi_{1i} \Delta\, logCust_{t-i} + \gamma_1 ECT_{t-1} + u_{1t} \quad (XVIII)$$

$$\Delta\, logrincome_t = \alpha_2 + {}^{j}\textstyle\sum_{i=1} \pi_{2i} \Delta\, logElect_{t-i} + {}^{k}\sum_{i=1} \beta_{2i} \Delta\, logrincome_{t-i} + {}^{m}\sum_{i=1} б_{2i} \Delta\, logprelect_{t-i} + {}^{n}\sum_{i=1} \rho_{2i} \Delta\, logApp_{t-i} + {}^{p}\sum_{j=1} \varphi_{2i} \Delta\, logCust_{t-i} + \gamma_2 ECT_{t-1} + u_{2t} \quad (XIX)$$

$$\Delta\, logprelect_t = \alpha_3 + {}^{j}\textstyle\sum_{i=1} \pi_{3i} \Delta\, logElect_{t-i} + {}^{k}\sum_{i=1} \beta_{3i} \Delta\, logrincome_{t-i} + {}^{m}\sum_{i=1} б_{3i} \Delta\, logrelect_{t-i} + {}^{n}\sum_{i=1} \rho_{3i} \Delta\, logApp_{t-i} + {}^{p}\sum_{j=1} \varphi_{3i} \Delta\, logCust_{t-i} + \gamma_3 ECT_{t-1} + u_{3t} \quad (XX)$$

$$\Delta\, logCust_t = \alpha_4 + {}^{j}\textstyle\sum_{i=1} \pi_{4i} \Delta\, logElect_{t-i} + {}^{k}\sum_{i=1} \beta_{4i} \Delta\, logrincome_{t-i} + {}^{m}\sum_{i=1} б_{4i} \Delta\, logprelect_{t-i} + {}^{n}\sum_{i=1} \rho_{4i} \Delta\, logApp_{t-i} + {}^{p}\sum_{j=1} \varphi_{4i} \Delta\, logCust_{t-i} + \gamma_4 ECT_{t-1} + u_{4t} \quad (XXI)$$

$$\Delta\, logApp_t = \alpha_5 + {}^{j}\textstyle\sum_{i=1} \pi_{5i} \Delta\, logElect_{t-i} + {}^{k}\sum_{i=1} \beta_{5i} \Delta\, logrincome_{t-i} + {}^{m}\sum_{i=1} б_{5i} \Delta\, logprelect_{t-i} + {}^{n}\sum_{i=1} \rho_{5i} \Delta\, logApp_{t-i} + {}^{p}\sum_{j=1} \varphi_{5i} \Delta\, logCust_{t-i} + \gamma_5 ECT_{t-1} + u_{5t} \quad (XXII)$$

(i = 1, 2, 3, 4, 5,……)

Where $lorElect_t$, $logrincome_t$, $logprelect_t$, $logCust_t$ and $logApp_t$ represents logarithmic forms of electricity consumption, real income, electricity prices, no. of customers and electric appliances. In these formulated error correction equations the entity ECT signifies the estimated residual term and its coefficient "$\gamma$" represents the speed of adjustment to equilibrium position. Thus the strength, significance and size of the Error Correction term (ECT) measures the speed of adjustment to long run equilibrium after the short run shocks. Significant t-value and negative sign of ECT fortifies long run causal consequence. Negative sign of coefficient of ECT (adjustment parameter) guarantees stable

[vi] That lag length is used for which Schwartz and Bayesian Criteria (SBC) value is minimal.

long run linkage and stability of the model also that the direction of the relation is toward equilibrium. Thus statistical significant and negative sign illustrates non-explosive series and attainability of long run equilibrium relation.

## 5. RESULTS AND ANALYSIS

This section provide the results derived through empirical and estimation techniques about the nature, behavior, performance and characteristic of electricity demand models for Pakistan (aggregate and disaggregate level), as stated in the former section.

**Unit Root Test:** Under the estimation of the data, the first step is to check the stationarity of the variable for that unit root test is carried out. Unit root test is utilized through Augmented Dickey Fuller (ADF) and Phillip Perron (PP) tests. Table (4) represents the results obtained through ADF and PP tests. Results of both ADF and PP tests explicate the presence of unit root problems in all variables at 5% level of significance. For the specification of unit root test intercept (constant) term is used, to check the stationarity of the variables with drift (other factors). All studies i.e. Al-Faris (2002), Narayan (2007) and Jamil and Ahmad (2010) also have used intercept term for the specification of the unit root test. Thus any result obtained through this non-stationary level series would be inconsistent and invalid. However, all variables become stationary at first difference and the hypothesis of non-stationarity is rejected at first difference at the 1% and 5% level of significance.

The outcomes of unit root tests also elucidate that all variables i.e. electricity consumption, real income, electricity prices, no. of customers and stock of electric appliances integrate at order I (1). These results strengthen and justified the utilization of Johansen cointegration technique. As similar integration order is a necessary condition for Johansen test and in this study all variables of aggregate and disaggregate models have integration order of one. Therefore, the next step is to analyze that whether the series of these variables integrate in the long run or not. In other words in the following section the Johansen test is applied for the determination of long run relationships among the variables.

**Table 4. Results of Unit root Test**

| Sector/ Variable | ADF | | Philips-Perron (P) | | Order of Integration |
|---|---|---|---|---|---|
| | Levels | First difference | Levels | First difference | |
| **Aggregate** | | | | | |
| Elect | -1.53 | $-4.30^{*}$ | -0.91 | $-4.36^{*}$ | *I (1)* |
| Rincome | -0.65 | $-4.38^{*}$ | -0.34 | $-4.40^{*}$ | *I (1)* |
| Prelect | -2.28 | $-5.74^{*}$ | -2.47 | $-5.73^{*}$ | *I (1)* |
| Cust | -0.22 | $-3.41^{***}$ | -0.49 | $-3.42^{***}$ | *I (1)* |
| App | -2.09 | $-5.92^{**}$ | -2.18 | $-5.91^{**}$ | *I (1)* |
| **Residential** | | | | | |
| Elect | -0.94 | $-4.83^{*}$ | -1.19 | $-4.68^{*}$ | *I (1)* |
| Rincome | -0.53 | $-5.26^{*}$ | -0.65 | $-5.28^{*}$ | *I (1)* |
| Prelect | -2.26 | $-5.77^{*}$ | -2.39 | $-5.76^{*}$ | *I (1)* |
| Cust | -1.32 | $-4.45^{*}$ | -1.35 | $-4.46^{*}$ | *I (1)* |
| App | -2.09 | $-5.92^{**}$ | -2.18 | $-5.91^{**}$ | *I (1)* |
| **Industrial** | | | | | |
| Elect | -0.71 | $-4.10^{*}$ | -0.1 | $-4.06^{*}$ | *I (1)* |
| Rincome | -0.94 | $-5.08^{*}$ | -0.54 | $-5.15^{*}$ | *I (1)* |
| Prelect | -2.32 | $-5.68^{*}$ | -2.48 | $-5.67^{*}$ | *I (1)* |
| Cust | -1.63 | $-9.62^{**}$ | -1.6 | $-9.65^{**}$ | *I (1)* |
| App | -2.09 | $-5.92^{**}$ | -2.18 | $-5.91^{**}$ | *I (1)* |

| | | | | | |
|---|---|---|---|---|---|
| **Commercial** | | | | | |
| Elect | -0.47 | -5.25* | -0.64 | -5.24* | *I (1)* |
| Rincome | -0.46 | -5.83** | -0.12 | -5.89** | *I (1)* |
| Prelect | -2.39 | -5.58* | -2.57 | -5.57* | *I (1)* |
| Cust | -2.15 | -4.24* | -3.05 | -4.35* | *I (1)* |
| App | -2.09 | -5.92** | -2.18 | -5.91** | *I (1)* |
| **Agricultural** | | | | | |
| Elect | -0.58 | -5.45* | -0.55 | -5.37* | *I (1)* |
| Rincome | -0.87 | -6.10** | -0.79 | -6.16** | *I (1)* |
| Prelect | -1.99 | -6.19** | -2.04 | -6.19** | *I (1)* |
| Cust | -1.55 | -8.32** | -1.29 | -8.72** | *I (1)* |
| App | -2.09 | -5.92** | -2.18 | -5.91** | *I (1)* |

Notes: Unit root test is applied with an intercept term. Here the lag length of each variable is determined through Schwartz and Bayesian Criteria (SBC). *(**) (***) Reflects the rejection of null hypothesis of unit root problem (non-stationarity) of variables at 5% (1%) (7%) level of significance.

**Johansen Cointegration Test:** Johansen cointegration technique is applied on such series that is non-stationary at level form to analyze and test their cointegration. The results obtained through unit root confirm that variables are non-stationary at the level form thus the Johansen test is carried out. Results of Johansen cointegration test elaborate that the null hypothesis of no cointegration relation is rejected at 1% and 5% level of significance. The alternative hypothesis of cointegrating series is accepted and explicates that in aggregate and commercial sectors two cointegration relations exist as trace statistics is greater and significant than critical values at most rank ($r \leq 2$).

However, in the industrial, residential and agriculture sector null hypothesis of no cointegration cannot be rejected for two or greater cointegration vectors. Thus based upon the results stated in table (5) it can be deducted that there exist long run relationships in electricity demand and its determinants i.e. real income, electricity prices, number of customers and stock of electric appliances for all aggregated and disaggregated electricity models. Now the next step is to analyze the stability of this long run linkage by estimating vector error correction model (VECM).

**Table 5. Johansen Cointegration Test**

| **Hypothesized No. of CE(s)** | **Eigenvalue** | **Trace statistics** | **5 percent Critical Value** | **1 percent Critical Value** |
|---|---|---|---|---|
| **Aggregate** | | | | |
| None** | 0.65809 | 112.8423 | 68.52 | 76.07 |
| At most 1** | 0.59360 | 73.13362 | 47.21 | 54.46 |
| At most 2** | 0.46301 | 39.81809 | 29.68 | 35.65 |
| **Residential** | | | | |
| None** | 0.53587 | 78.87714 | 68.52 | 76.07 |
| At most 1* | 0.41475 | 49.70868 | 47.21 | 54.46 |
| At most 2 | 0.33531 | 29.35125 | 29.68 | 35.65 |
| **Industrial** | | | | |
| None** | 0.63112 | 80.93393 | 68.52 | 76.07 |
| At most 1 | 0.43018 | 44.03415 | 47.21 | 54.46 |
| At most 2 | 0.38348 | 23.22380 | 29.68 | 35.65 |
| **Commercial** | | | | |
| None** | 0.60973 | 100.4597 | 68.52 | 76.07 |
| At most 1** | 0.54928 | 65.64550 | 47.21 | 54.46 |
| At most 2** | 0.47068 | 36.15920 | 29.68 | 35.65 |
| **Agriculture** | | | | |
| None* | 0.57285 | 71.38717 | 68.52 | 76.07 |
| At most 1 | 0.31053 | 38.21301 | 47.21 | 54.46 |
| At most 2 | 0.26616 | 23.71132 | 29.68 | 35.65 |

(a) *(**) denotes rejection of null hypothesis of no cointegration at 5% and (1%) significance level.

(b) Critical values are taken from Mackinnon-Michells.
(c) Johansen Cointegration test results are used at lag interval 1 to 2, which is determined by Schwartz and Bayesian Criteria (SBC).

**Vector Error Correction Model (VECM):** After discussing the results of long run linkage among a series of electricity demand models, the next step is to analyze the short run dynamics through VECM. Under short run dynamics the stability of the model is crucial and this will be done by focusing on ECT obtained through VECM. The coefficient of ECT provides the speed with which variable returns to its equilibrium position in the long run so the value of ECT should be negative and statistically significant. As a negative sign indicates the convergence in short run dynamics. Results of ECT are obtained from estimation and stated in table (6). Results of ECT represent that in all five models i.e. aggregated, residential, industrial, commercial, and agriculture the coefficient is negative confirming the convergence of the model to long run equilibrium. Table (6) also elaborates that the ECT of five models is statistically significant at 5% level of significance, as its t-statistics explains and is stated in parenthesis. No doubt results about speed of adjustment coefficient obtained through VECM are significant and negative for all models but the value or strength of the speed differs in all of them. In aggregate electricity demand model the value of ECT is -0.565, which explicates that in every year 56.5% of the error is adjusted in the previous year and 56.5% of the short run fluctuations are acceptable in long run trend. This moderate value of adjustment parameter reflects that after short run fluctuation the speed of adjustment to long run equilibrium is moderate. T-value of ECT in this model (aggregate electricity demand model) is 2.123, which is significant at the 95% level of confidence.

**Table 6: Vector Error Correction Model and Short Run Dynamics**

| Variables | Aggregate | Residential | Industrial | Commercial | Agricultural |
|---|---|---|---|---|---|
| ΔElect (-1) | 0.194 | 0.444 | 0.422 | 0.307 | -0.037 |
| | (0.251) | (0.154) | (0.267) | (0.229) | (0.184) |
| | (2.774**) | (2.873**) | (1.579) | (1.339) | (1.203) |
| Constant | 0.009 | 0.062 | 0.025 | -0.019 | 0.092 |
| | (0.036) | (0.020) | (0.101) | (0.028) | (0.082) |
| | (2.271*) | (3.046**) | (2.249*) | (1.708) | (1.117) |
| Δrincome (-1) | 0.315 | 0.183 | 0.060 | 0.001 | 0.724 |
| | (0.546) | (0.177) | (0.267) | (0.167) | (0.241) |
| | (2.577**) | (2.472*) | (2.227*) | (2.005*) | (3.002**) |
| Δprelect (-1) | -0.189 | -0.418 | -0.214 | -0.299 | -0.139 |
| | (0.177) | (0.172) | (0.274) | (0.265) | (0.112) |
| | (-2.069*) | (-2.420*) | (-2.781**) | (-1.129) | (-1.937*) |
| ΔCust (-1) | 0.289 | 0.060 | 1.738 | 0.547 | 0.471 |
| | (0.288) | (0.063) | (0.632) | (0.882) | (0.269) |
| | (2.003*) | (3.946**) | (2.748**) | (2.415*) | (2.207*) |
| ΔApp (-1) | 0.028 | 0.290 | 0.025 | 0.085 | 0.003 |
| | (0.053) | (0.048) | (0.059) | (0.061) | (0.060) |
| | (2.543**) | (1.881*) | (2.420*) | (1.384) | (2.056*) |
| ECT | -0.565 | -0.222 | -0.385 | -0.330 | -0.471 |
| (t-statistics) | (-2.123*) | (-2.670**) | (-3.479**) | (-3.362**) | (-3.705**) |
| $R^2$ | 0.500 | 0.541 | 0.673 | 0.526 | 0.475 |
| Adj. $R^2$ | 0.480 | 0.452 | 0.597 | 0.518 | 0.445 |
| S.E of equation | 0.057 | 0.066 | 0.072 | 0.067 | 0.068 |
| DW | 2.177 | 2.153 | 1.819 | 2.089 | 1.700 |
| White (F-Prob) | 0.120 | 0.379 | 0.830 | 0.174 | 0.641 |
| F-statistics | 8.274 | 6.093 | 11.354 | 12.531 | 12.064 |
| Ramsey Reset Test (F-Prob) | 0.004 | 0.090 | 0.066 | 0.001 | 0.079 |

*(a) Figures in parenthesis represent the standard error and t-statistics of the variables.*
*(b) ECT indicates the error correction term, for calculating speed of adjustment.*
*(c) * (**) donates significance at 5% and (1%) level.*
*(d) "DW" indicates Durbin-Watson and "White" reflects Heteroscedasticity test.*

**Table 7: Long Run Elasticities**

| Variables | Aggregate | Residential | Industrial | Commercial | Agricultural |
|---|---|---|---|---|---|
| Dependent variable (Elect) | | | | | |
| Constant | 3.167 | 5.388 | 5.243 | 2.321 | 14.910 |
| rincome | 0.251 | 2.505 | 1.041 | 0.516 | 1.001 |
| | (0.347) | (0.611) | (0.123) | (0.316) | (0.540) |
| | (2.723**) | (4.099**) | (8.461**) | (1.631*) | (1.875*) |
| prelect | -0.853 | -1.743 | -0.558 | -1.834 | -1.668 |
| | (0.593) | (0.066) | (0.242) | (0.847) | (0.996) |
| | (-1.438) | (-1.633*) | (-2.300*) | (-2.164*) | (-1.859*) |
| Cust | 0.074 | -0.067 | -1.714 | 0.624 | -0.930 |
| | (0.188) | (0.130) | (0.354) | (0.424) | (0.400) |
| | (2.396*) | (2.516**) | (4.839**) | (1.471) | (1.627*) |
| App | 0.640 | 0.292 | 0.230 | 0.264 | 1.690 |
| | (0.276) | (0.106) | (0.050) | (0.170) | (0.299) |
| | (3.318**) | (2.762**) | (4.591**) | (1.551*) | (2.779**) |

*(a) Figures in parenthesis represent the standard error and t-statistics of the variables.*
*(b) * (**) donates significance at 5% and (1%) level.*

Similarly, the coefficient value of adjustment parameter (ECT) in residential, industrial, commercial and agricultural electricity demand models is -0.222, -0.385, -0.330 and -0.471 respectively. These values indicate that 22.2%, 38.5%, 33.0% and 47.1% of the error is adjusted and corrected in respective models. All these values are negative indicating convergence to long run equilibrium and statistically significant at 1% and 5% levels of significance.

To explore the more responsive behavior of elasticities of electricity demand determinants long and short run elasticities are estimated. Long run elasticities are acquired through Johansen cointegration technique and stated in table (7). Results of long run income elasticities explain that in all sectors the value of income elasticity is positive confirming it as normal good. As far as the value of income elasticity is concerned it is greater than unity in all sectoral models except aggregate and commercial sectors. Income elasticity in aggregate, residential, industrial, commercial and agriculture sectors is 0.251, 2.505, 1.041, 0.561, and 1.001 respectively. As income elasticity is greater than unity in all sectors except aggregate and commercial sectors, based upon this upshot it can be deducted that according to income changes electricity acts as luxury good in residential, industrial and agricultural demand models. Since in Pakistan electricity is not completely in the reach of every people as according to Khan and Qayyum (2008) and Jamil and Ahmad (2010) 30 to 40 per cent of the area of Pakistan is not yet connected to the national electricity grid. On other hand income elasticity at aggregate and commercial sectors is 0.251 and 0.561 respectively, which affirm it as a necessity.

Price elasticity at aggregate, residential, industrial, commercial and agriculture sectors is -0.853, -1.743, -0.558, -1.834, and -1.668 respectively. Signs of price elasticity in all five models are negative; affirming that as the electricity prices raise the electricity demand falls. Long run price elasticity in all models except aggregate and industrial sectors is greater than unity indicating that electricity is a luxury commodity at residential, commercial and agriculture level. While at aggregate and industrial sectors price elasticity is less than unity and describes electricity as a necessity due to the fact that in present times consumption of electricity is significantly high and one cannot think of developed and comfortable life without electricity. Results of both income and price elasticities are statistically significant at 1 and 5 percent level of significance.

The number of customers and stock of electric appliances have positive long run effects on electricity consumption in all models except the negative sign of customer's variable at residential, industrial and agricultural sectors reflecting that at residential, industrial and agricultural scale as number of customer increases the consumption of electricity reduces due to the lack of availability of sufficient electricity. Results of elasticity of customers are significant in all sectors and are less than unity in all models except industrial sector, indicating that response of customers on electricity consumption is inelastic. Similarly inelastic response of electric appliances has seen with electricity demand, these results are significant in all five sectors.

Now moving towards the short run dynamic and talking about the short run elasticity results. Short run elasticities are derived through vector error correction estimates and stated in table (6). Short run income elasticities are significant and positive in all five sectors. The value of income elasticity in all five models is less than unity for short run, reflecting electricity as necessity. If short run price elasticities are considered the result of table (6) determine them as having negative signs, again the price elasticities in short run for all five models is less than unity confirming electricity as a necessity in the short run. These results of short run price elasticities are statistically significant at 1 and 5 percent level except the outcome of commercial sector that is moderately significant.

As far as the short run results of a number of customers are concerned they explicate positive behavior in all five sectors. Customers have inelastic response in all cases except industrial sector where it is elastic. Customers have significant impact on aggregate, residential, industrial, and commercial and agriculture sectors. In short run electric appliances also have significant and positive influence on electricity demand in all five sectors.

If we talk about the goodness of fit and reliability of these long and short run dynamics we can analysis that F-statistic values are statistically significant for all five models used. Determination power of the model is also according to the expectations, as $R^2$ and adjusted $R^2$ are concern they range from 0.445 to 0.673 for five model now doubt these values of $R^2$ and adjusted $R^2$ are very low but previous studies of Al-Faris (2002), Galindo (2005), Khan and Qayyum (2008) and many others have recorded low determination power due to the nature of the study. The results of Durbin-Watson (DW) test for autocorrelation is stated in table (6). The value of DW ranges from 0 to 4, according to rule of thumb DW=2 reflects absence of autocorrelation problem. Results of DW test for all five models ranges from 1.700 to 2.177, indicating that problem of autocorrelation in all stated five models is not sever. To analyze the consistency of variance White heteroscedasticity test is used and results are provided in table (6). Results of White heteroscedasticity test reflect the presence of homoscedasticity as the value of F-probability of White heteroscedasticity test is well above 0.1 for all five cases. To check the specification of the models used, Ramsey Reset test is carried out which suggests that all five models are well specified. The null hypothesis of additive models is rejected as under F-statistics, probability (p-values) ranges from 0.001 to 0.090 in all five cases.

Based upon the elasticity results of electricity demand models it can be concluded that in long run electricity consumption shows elastic behavior with income level in all sectors except aggregate and commercial sectors and elastic with electricity prices except aggregate and commercial sectors. On the other hand income and electricity prices establish inelastic response with electricity consumption in short run. Both income level and electricity prices give expected positive and negative sign respectively with electricity demand. Moreover, customers and stock of electric appliances prove to be significant determinants of electricity demand with expected signs, but their response is inelastic in the majority of the sectors. Summary of Results of studies related to different countries and Pakistan are stated in table (1) with respect to income and price elasticities for electricity demand. Where in long run income possesses positive signs and has elastic responses for electricity demand reflecting electricity as a luxury good and are according to the results of this study. On the other hand, long run price elasticities have mixed behavior in both previous and current studies but have negative influence on electricity consumption in both cases. In some sectors long run price elasticity is elastic and in some sectors this value is inelastic, in this current study long run price elasticity has elastic response in residential, commercial and agriculture sectors indicating electricity consumption as luxury good while have inelastic response in aggregate and industrial electricity consumption levels and in these sectors electricity acts as a necessity.

As far as the short run dynamics is concerned, comparison of prior studies and current literature in this study fortifies that in short run income and electricity prices have inelastic response with positive and negative signs respectively in all of the sectors, determining electricity demand less responsive in short run and as a necessity for life. Thus based upon the comparison of the results of this study with the key studies stated in chapter two it can be concluded that both results support each other and have a consistent path for policy implication and electricity demand management.

## 6. RESULTS AND DISCUSSION

For the last few years electricity demand has rapidly increased in Pakistan and asks for demand management policies and further investment for power generation to cope with the increasing demand. Thus this paper attempts to investigate the determinants of electricity demand, the current electricity crisis and the impact of electricity determinants on its consumption. For this aggregate and disaggregate data is used from 1970 to 2010. Current electricity crisis has influenced the whole economy. Electricity crisis has mainly affected the industries, exports and employment. Where industrial losses have reached to 157 billion rupees, unemployment losses are about 400,000. On average industrial and export growth has demised to 2.4 and 1.2 percent respectively in last few years due to ongoing electricity crisis, which pulled back the economic growth so economic growth has decreased to 2 percent in last few years. According to Ghaus (2010) currently the whole economy is facing a 210 billion rupee loss as a response to current power crises.

For the determination of the order of integration and stationarity unit root test is applied. Results of Augmented Dickey Fuller (ADF) and Phillip Perron (PP) test confirm the existence of unit root problems as all variables are non-stationary at level form but are stationary at level form that awoke for the use of Johansen cointegration test for the verification of long run association among electricity demand and its determinants. Results of cointegration test fortify that in all five models (aggregate, residential, industrial, commercial and agriculture) vector of variables integrate, proving the existence of long run relationships among electricity demand and its determinants. As far as the stability of this linkage is concerned an error correction model is applied. Results of error correction term (adjustment parameter) gives significant values for all five models having negative sign, indicating that in all five models after fluctuation relation converge to equilibrium. Nevertheless, this speed of adjustment towards equilibrium varies among different sectors, where the aggregate sector has higher speed of adjustment having value -0.565 indicating that 56.5 percent of the error is adjusted in one-year time span. While the residential sector has a minimum value of about -0.222 reflecting that in the residential sector convergence towards equilibrium is slow. Results of short and long run elasticities elucidates that in short run all determinants have low elasticities; response of electricity demand with income and prices is inelastic, representing that in short run most of the people consider electricity as a necessity. Therefore, under this short run response, effective income and price policy requires a component of shock and that shock must be significant in order to influence the consumption levels in all sectors. Other determinants of electricity demand i.e. customers and stock of electric appliances also have inelastic and significant effect on electricity consumption. Electricity prices have expected negative influence on electricity consumption while real income, customer and electric appliances positively affect electricity demand. All of these short run results are significant at 1 and 5 percent level of significance in all five models. To the degree that long run elasticities are concern all variables explicate desire signs except the customer’s variable in the residential, industrial and agriculture sectors indicating that as number of customer increases in these sectors electricity consumption decreases due to the insufficiency of electricity supply. In all five models estimates are significant. Long run income elasticity is greater than unity in majority of the sectors and refers to electricity as a luxury good justified by the fact that 30 to 40 percent of Pakistanis are lacking access to electricity. However income elasticity at aggregate and commercial sector is inelastic indicating electricity as a necessity in these sectors. Long run price elasticities in aggregate and industrial sectors are inelastic, suggesting electricity as a necessity in these sectors awaking for significantly responsive price policy in these sectors for changing consumption levels. Further, at the residential, commercial and agriculture sectors price elasticities are greater than unity as electricity appears a luxury good in these models. In the long run other influencing factors i.e. customers and electric appliances are inelastic and significant.

Results and analysis of this study suggest valuable policy implications that electricity demand management should focus on the effective income and price policies for each sector to control this increasing demand. In long run electricity demand is income and price elastic at residential and agriculture sectors thus price decrease is best response in these sectors. In aggregate and commercial sectors income elasticity affirms electricity as a necessity and in aggregate and industrial sectors price elasticity has inelastic response so keeping in view this inelastic reaction of electricity in stated sectors, increasing price policy is the best demand management policy to curb the increasing demand. Suggesting short run policy, it has been noticed that electricity demand has inelastic response in all sectors for both income and electricity prices thus in short run effective demand management policy should increase electricity prices and that effect should be significant. Results of this study explains that response of electricity demand in each sector is different thus unique demand management policy is not effective so based upon the response of each sector, different demand management and group pricing policies should formulated in each sector. In addition to that peak-load pricing policy should be practiced in Pakistan, where high prices should be charged at peak-load hours of electricity consumption in order to sustain the boasting electricity demand. Over the last few years such steps have been taken which rapidly raised the supply of electric appliances at a cheaper rate and consequently electricity consumption has drastically increased. Keeping in view that electric appliances have significant influence on electricity consumption, such policies should be reviewed. In addition to these policy measures government also needs to improve and install new energy generating plants and the infrastructure. Private sector should be encouraged in the electricity sector to break the existing natural monopoly and to increase competition. New clean and cheaper substitutes of electricity should be introduced. Finally energy and electricity conservation strategies should be applied in all sectors for effective and productive uses.

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