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Impact of Energy Sources and the Electricity Crisis on the Economic Growth: Policy Implications for Pakistan

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Abstract

The electricity crisis in Pakistan is a very real problem and because of this, life as we know it in Pakistan is extremely challenged. Imagine living in a country with power outages accounting for more than 12 hours a day with in the urban centers of the country and with only a couple of hours of electricity in the rural areas. With people living in such abject circumstances, how can one consider their country to grow economically? If we look closely at the energy deficit we find various problems pointing towards bad governance. At a glance if we examine the energy issue we get puzzled, because the total demand for energy in the country roughly amounts to 17,000 Megawatts while the total energy production capacity of the existing apparatus is 22,797 Megawatts. The total energy being produced by the existing apparatus fluctuates around 12-13,000 Megawatts. The reasons for under production are owed to bad governance and poor resource management due to which a circular debt is created within the energy supply chain. The aim of this study is to build a sound understanding of the results attained by the numerical/statistical analysis using data from Pakistan and compare them with the existing literature, thus enabling the authors to develop, meaningful policy recommendations. The statistical analysis using the GMM technique corresponds with the existing literature and point towards the fact that, in the case of Pakistan there exists a "growth hypothesis"; highlighting a strong relationship between electricity consumption and economic growth, and that economic growth is significantly dependent on electricity.

Keywords: Energy Crisis, Pakistan Electricity Production, Relation between Electricity Consumption and Economic Growth, China Pakistan Economic Corridor.

1. Introduction

Energy has undisputable significance for the sustenance of modern human life. The provision of affordable and adequate energy is a prerequisite to address the basic human difficulties like poverty mitigation, human welfare and enriching the living standard across the planet. The human development Index (HDI) of a country has a strong relationship with the country's prosperity as the Gross National Income (GNI) is an integral variable in the calculation of the HDI (UNDP 2017) and thus we can infer its importance; because per capita consumption of energy is the measure of socioeconomic prosperity in any society (International Energy Agency IEA 2016).

Energy demanded has been on a consistent rising trend throughout the recorded history of mankind. But within the last century this demand has taken a sharp upward trend owing to the fact that within the last 50 years, the global population burgeoned quickly than ever before. In 1950, the global population stood at 2.5 billion people; and in 2005 this figure had reached 6.5 billion people. (Population Reference Bureau 2016) This is the fastest rise ever recorded in human history, in 2017 is estimated to stand at 7,515,284,153 people in other words it is 7.5 billion people. (Worldometers 2017) Out of the 7.5 Billion roughly 4.5 billion people reside in one continent namely Asia, which comprises mostly of the developing world. (Worldometers 2017) Within Asia our country under the scope which is Pakistan, houses the 6th largest population in the world which is estimated at 0.19 billion (Worldometers 2017) thus raising the demand for energy in the country. The problem in Pakistan is that just like the world population, the population of Pakistan has also risen very fast during the last 2 decades, overtaking the government's policies for the provision of infrastructure for public goods; electricity and energy are part of the key goods for which there is high demand and less supply. Electricity is vital for economic growth.

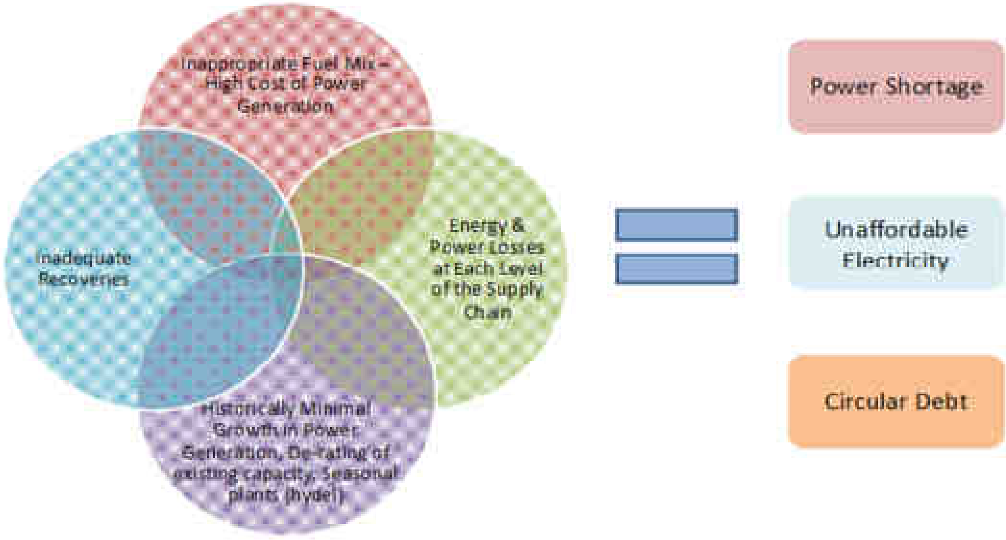

Figure 1. Electricity Crisis in Pakistan (Source: Mansoor 2015)

There are many reasons for the energy crisis in Pakistan a few will be briefly touched upon here in this section as there is a separate section dedicated to the electricity crisis in Pakistan which explores and explains this deeply entrenched problem in Pakistan. The origins of the energy crisis were crowned back in 1994 when it was observed that there is a shortage of 2,000 MW (PPIB 1994)in Pakistan and to bridge this gap the Government of Pakistan issued its energy policy in 1994 (PPIB 1994) which went on to change the energy mix dynamics of Pakistan and the country moved away from the dominant source of power production (hydro) to thermal, because the energy policy 1994 encouraged and welcomed foreign investments for thermal power plants and among the thermal plants furnace-oil based plants gained acceptance which were easier to establish and connect with the national power grid system. This shift in policy and the tilt towards furnace-oil and natural gas based power plants and the neglect towards coal powered power plants are one of the reasons behind the energy crisis. Furnace oil is the most expensive source among other thermal sources of Power and it needs to be imported which is another burden on the national exchequer, due the burden of high payments for this energy source, payments were delayed to the independent power plants, which started operation at lower than optimal levels of production and this triggered a chain of events which resulted in the circular debt. Other reasons for the energy crisis that will be highlighted with in this research comprise of rampant electricity theft with in the country, non-payments of electricity dues, approval of rental power plants, lack of long-term planning for the energy mix, and issuance of subsidies which lower the drive for enhancing productivity and efficiency among the power companies. Currently due to the issues mentioned above it was recorded during the peak demand season of summer of 2016 the electricity gap between supply and demand hovered around 4500 MW to 5500 MW (Kiani 2016).

1.1 Purpose of the Study

As explained above, this research focuses on the "power generation" aspect and the "electricity distribution" aspect of the electricity sector of Pakistan and more specifically stress is laid on the energy mix of the country. Past trends of the energy mix will be studied; data will be compiled from primary sources and computed. this research aims at empirically examining the time series data of the various sources of power generation in Pakistan and then identifying which among them has been the least productive in terms of power generation, in terms of contribution towards the GDP of the country, this analysis will help build a concrete understanding of the problems associated with Pakistan's energy mix, the various sources attributed towards generating power and will empirically help bridge the gap between theorized international trends and the power sector problems in Pakistan, once this understanding is developed plausible recommendations can be made to address the issues of selecting the correct energy mix for Pakistan, which can contribute in aiding policy makers in Pakistan in formulating future energy policies of the country.

2. Literature Review

In recent years the issues of energy consumption and economic development have become the concern of many parties, particularly policy makers. The empirical outcomes of previous studies examining the relationship between energy consumption and economic growth have been inconclusive and conflicting due to different sample periods, variables used, countries studied and econometric techniques employed.

2.1 Relation between Energy and Economic Growth World Wide

The relationship between energy consumption and economic growth has been studied extensively in the literature. After our thorough literature review it has been observed that all the studies conducted on similar topics as that of the current research can be divided in to four generations. All these studies have been conducted on this subject owing to the significance of the subject. In order to understand how the research has progressed over the years all four generations need to be addressed. Among the first generation of studies; The pivotal empirical study on this subject was conducted by Kraft and Kraft in 1978 who calculated and uncovered unidirectional causality running from GNP to energy consumption, they carried out this study using data from the US and the time period they selected was from 1947-1974 (Kraft J 1978). Apart from Kraft and Kraft's study other early and significant studies from the first generation of studies examining the direction of causality assuming stationarity of the causal variables include; studies conducted by Yu and Choi in 1985 who examined the GDP-Energy Consumption relationship in two directions first, the causal relationships between GNP and energy were examined from an international perspective; five countries in various stages of development were selected for the purpose of comparison and generalization. Second, the causal linkage between GNP and the aggregate as well as several disaggregate categories of energy consumption, including solid fuels, liquid fuels, natural gas, and others (i.e., hydro, nuclear and electricity). Yu and Choi's significant contribution to the literature was that, "relationship between energy and GNP varies among countries and the results of causality tests are fairly sensitive to samples." (E.S.H. Yu 1985) another study of significance was conducted by Erol and Yu in 1987 their focus was on determining the causal relationship between energy and income for industrialized countries. (Erol U 1987). Abosedra and Baghestani in 1989 found new evidence and linkages on the causal relationship between US energy consumption and gross national product. (S. Abosedra 1989)

Next comes the second generation of studies conducted using Granger Causality methods which were developed by Engle and Granger (C.W.J. Granger 1988), this involved a two-step approach, in which pairs of variables were studied to account for co-integration relationships. In-order to test for Granger causality estimated error-mitigation models were utilized. This generation of studies provided interpretation for non-stationarity in the data. The significant studies of this generation include as study by Nachane, Nadkarni, and Karnik in 1988 which utilized co-integration and causality testing for Energy and GDP by performing a cross-country data. (D.M. Nachane 1988). Cheng and Lai did a similar co-integration between energy and economic activity in 1997 (B.S. Cheng 1997); Glasure and Lee studied co-integration, error-correction, and the relationship between GDP and energy and they used a case study of South Korea and Singapore (Y.U. Glasure 1997).

The third generation of studies uses multivariate estimators just like Johansen's multi-variate approach. This approach allows researchers to use two or more variables and determine the co-integration relationships (Johansen 1991). Significant studies within this generation include; a study conducted in 1997 by Masih who along with his colleague studied the temporal causal relationship between energy consumption, real income, and prices and they were able to provide some new evidence in the context of the developing Asian economies; their study was based upon a multivariate co-integration/vector error-correction approach. (A.M.M. Masih 1997) Apart from Masih's study, Stern's study based upon a multivariate co-integration model which analyzed the role of energy in the US economy was another significant study within the third generation (Stern 2000). Other important studies in the time period include Asafu-Adjaye's study determining the relationship between energy consumption, energy prices and economic growth, he used a time series analysis and provided evidence for this relationship present in the developing countries of Aisa (J. Asafu-Adjaye 2000); Soytas and Sari conducted another meaningful research which covered the energy consumption and GDP: causality relationship in G-7 countries and emerging markets (U. Soytas 2003); Oh and Lee also contributed significantly towards the available literature by first revisiting case of Korea and covered the time period of 1970-1999 and determined the causal relationship between energy consumption and GDP and then published another work in which they tested this relations (W. Oh, Causal Relationship between Energy Consumption and GDP Revisited: The Case of Korea 1970-1999 2004) (W. Oh, Energy Consumption and Economic Growth in Korea: Testing the Causality Relation 2004).

Finally, we come to the fourth generation of studies which have been recently developed and this research will also contribute to this generation, within this generation panel-econometric methods have been utilized for the examination of unit roots and co-integration relationships. The studies here estimate panel-based error-correction models to perform Granger causality tests and Lee's study based on energy consumption and GDP within developing countries, presents a co-integrated panel analysis (Lee 2005). Al-Iriani also explained the energy-GDP relationship but he explained this relationship in the context of GCC countries and used panel causality (Al-Iriani 2006). Other contemporary works within this generation include Mahadevan and Asafu-Adjaye's work in which they reassessed energy consumption, economic growth and prices using panel VECM for developed and developing countries (John Asafu-Adjaye 2007), Lee and Chang's work on energy consumption and GDP in which they performed a panel analysis of developed and developing countries (Chien Chiang Lee 2007), another study conducted by Nicholas Apergis and James E. Payne revealed that a long-run equilibrium relationship between real GDP, energy consumption, labor force, and real gross fixed capital formation with the respective coefficients positive and statistically significant, they deduced this by examining the relationship between energy consumption and economic growth for a panel of nine South American countries over the period 1980–2005 within a multivariate framework. (Nicholas Apergis 2010), Lee and Lee's work on finding the relationship between income and CO2 emissions they used Panel unit root and co-integration tests to secure evidence. (C. C. Lee 2009), Costantini and Martini's study of the causality between energy consumption and economic growth revealed that the causal relationship between economy and energy by adopting a Vector Error Correction Model for non-stationary and cointegrated panel data with a large sample of developed and developing countries and four distinct energy sectors. The results show that alternative country samples hardly affect the causality relations, particularly in a multivariate multi-sector framework (Valeria Costantini 2010). Results compiled from the above mentioned literature are compiled in table-1.

Table 1. Summary of Studies Selected Providing Global Perspective

Study	**Method**	**Countries**	**Result**
Kraft & Kraft (1978)	Bivar. Sims Causality	USA	Growth→Energy
Yu & Choi (1985)	Bivar. Granger test	South Korea, Philippines	Growth→Energy Energy → Growth
Erol and Yu (1987)	Bivar. Granger test	USA	Energy ~ Growth
Yu and Jin (1992)	Bivar. Granger test	USA	Energy ~ Growth
Masih and Masih (1996)	Trivar. VECM	Malaysia, Singapore & Philippines India Indonesia Pakistan	Energy ~ Growth Energy → Growth Growth →Energy Energy ←→Growth
Glasure and Lee (1998)	Bivar. VECM	South Korea & Singapore	Energy ←→Growth
Masih and Masih (1998)	Trivar. VECM	Sri Lanka & Thailand	Energy → Growth
Asafu-Adjaye (2000)	Trivar. VECM	India & Indonesia Thailand&Philippines	Energy → Growth Energy ←→ Growth
Soytas and Sari (2003)	Bivar. VECM	Argentina South Korea Turkey Indonesia & Poland Canada, US & UK	Energy ↔ Growth Growth →Energy Energy → Growth Energy ↔ Growth Energy ↔ Growth
Oh and Lee (2004)	Trivar. VECM	South Korea	Energy ↔ Growth
Al-Iriani (2006)	Bivar. Panel VECM	Gulf Cooperation C	Growth → Energy
Lee and Chang (2008)	Mulitv. Panel VECM	16 Asian countries	Energy → Growth
Narayan and Smyth (2008)	Multiv. Panel VECM	G7 countries	Energy → Growth
Apergis and Payne (2009	Multiv. Panel VECM	6 Central American countries	Energy → Growth
Lee and Lee (2010)	Multiv. Panel VECM	25 OECD countries	Energy ↔ Growth
Kaplan et al. (2011)	Granger Causality Test	Turkey	Growth ←→Energy
Adom (2011)	Toda Yamamoto Granger Causality Test	Ghana	Growth →Energy
Souhila & Kourbali (2012)	Granger Causality Test	Algeria	Growth→ Energy
Apergis and Danuletiu (2012)	Panel Cointegration and VECM	Romania	Energy →Growth
Sabri Nayan et al. (2013)	Panel Cointegration GMM	23 Countries	Growth →Energy
Kais Saidi and Sami Hammami (2015)	Panel cointegration GMM	58 Countries	Growth → Energy
Rabia Komal, Faisal Abbas (2015)	GMM	Pakistan	Growth → Energy
Anthony N. Rezitis and Shaikh Mostak Ahammad (2015)	panel vector autoregression and Granger Causality Test	South and South East Asia	Growth ←→Energy
Molem Chirstopher Sama and Ndifor Roger Tah (2016)	GMM	Cameroon	Growth ←→Energy

2.2 Literature Reviewed for the Case of Pakistan (Electricity consumption and economic growth)

In the case of Pakistan there are several studies which investigated the causality between energy consumption and economic growth. These studies included (Anjum 2001) (Alam 2002) (Siddique 2004) (M. Arshad Khan 2007) (Zahid Asghar 2008) (Qazi Muhammad Adnan Hye 2008) (Z.K. Kakar 2011) (I.S. Chaudhry 2012) (Waqas Ahmed 2013) (Sana Nadeem 2016). The summary of these studies are given in the table-2.

Table 2. Summary of Studies Focusing on Pakistan

Study	**Method**	**Countries**	**Result**
Anjum & Butt (2001)	Hsiao's Causality	Pakistan	Growth→Energy
Alam & Butt (2002)	Granger Causality	Pakistan	Energy←→ Energy
R. Siddique (2004)	Granger Causality	Pakistan	Energy → Growth
Khan & Qayyum (2007)	Panel Co-integration	Pakistan, Bangladesh, India and Sri Lanka.	Energy →Growth
(Khalid Mushtaq 2007)	Johansen's co-integration and Granger causality	Pakistan	Growth→Energy
Asghar & Rahat (2008)	Panel Co-integration Granger Causality	South Asia	Growth → Energy
Qazi & Riaz (2008)	Granger Causality	Pakistan	Growth → Energy
(S. Noor 2010)	ECM and FMOLS	South Asia (including Pakistan)	Growth → Energy
Kakar et.al (2011)	Johansen Co incorporation and VEC model	Pakistan	Growth → Energy
(Muhammad Shahbaz 2012)	Toda Yamamoto and Wald-test causality	Pakistan	Growth →Energy
(M. Rashid 2012)	Granger Causality	Pakistan	Energy →Growth
Chaudhary et.al (2012)	Granger Causality	Pakistan	Growth → Energy
Ahmad et.al (2013)	Granger Causality	Pakistan	Energy ←→Growth
(M. Zeshan 2013)	Structural Vector Auto-regression	Pakistan	Growth →Energy
(Muzammil Khurshid 2013)	Return on Assets Ratio	Pakistan	Energy → Growth
(Samiullah 2014)	ARDL approach	Pakistan	Energy →Growth
(Jawaid 2014)	ARDL, JJ Co-integration and OLS	Pakistan	Energy→Growth
Rabia Komal, Faisal Abbas (2015)	GMM	Pakistan	Growth → Energy
Anthony N. Rezitis and Shaikh Mostak Ahammad (2015)	panel vector auto-regression and Granger Causality Test	South and South East Asia	Growth ←→Energy
(Imran Naseem 2015)	descriptive statistics, correlation and regression tests	Pakistan	Energy → Growth
(Rashid 2015)	Co-integration and VEC model	Pakistan	Energy → Growth
Nadeem & Munir (2016)	Granger Causality	Pakistan	Growth → Energy
(Syed Ali Raza 2016)	Pedroni's panel co-integration	Pakistan, India, Bangladesh and Sri Lanka	Energy→Growth

2.3 Theoretical Framework

We have seen from the literature that causality is present between economic growth and energy, this means that they effect each other. We know that energy, especially electricity is the backbone of an economy and shortage of electricity impacts economy especially in the case of Pakistan (Ministry of Finance 2012). After reviewing all the studies mentioned in table 1 and table 2 we can see that conceptually, energy consumption in an economy is directly affected by economic growth. Since we aim to study the impact of the energy short fall and the production of energy through different sources on economic growth, which we aim to augment the planning procedure for the development of a better future energy mix. Thus we will have to employ a multivariate framework. Based on the literature studied we can see that, empirical literature has highlighted; increase in income is a causal factor towards increase in energy consumption in developing economies (M. Shahbaz 2011). As production activities surge, electricity requirement for input in the production processes is generated which leads to increase in electricity demand, this phenomenon doesn't surface when we are observing a matured and economically developed subject country; where economic growth occurs in an energy efficient manner. This difference in results is owed to the utilization of high-end energy efficient equipment employed by the industries as well as the households within developed nations (Faridul Islam 2013). Once an economy matures, an economic shift occurs there by shifting the focus of the economy from manufacturing towards services; this helps in the reduction of energy-use thus reinforcing a hypothesized positive relation between economic growth and electricity consumption (M. Mehrara 2012).

Population also has a deep rooted impact on energy consumption especially electricity consumption, it has been observed that Pakistan's urban population has increased to 77.93 million in 2016 from 72.05 million in 2014 (State Bank of Pakistan 2016). Urbanization encompasses an enlargement of population that participates in economic activities thereby increasing energy consumption as well as electricity consumption (Jones 1991) (Shiu 2004).

As we have seen that in Pakistan the urban population is on the rise thus for the case of Pakistan it can easily be postulated that urbanization or population expansion is directly and more importantly significantly linked with higher electricity consumption (M. Shahbaz 2011). As we have seen that expansion in population increases the demand for electricity and if that demand is not met with the requisite supply then we have an energy shortfall and we have already seen from the literature that electricity consumption impacts economic growth within a developing nation thus is can be postulated that electricity shortfall will inversely impact economic growth (Imran Naseem 2015). Within the electricity system of Pakistan there are numerous problems contributing to the shortfall of electricity, these numerous problems include line losses and electricity theft. Line losses and electricity theft are very significant problems in Pakistan, because of two reasons; firstly because these losses amount up to a quarter of total of the electricity produced and secondly because this quarter of the electricity doesn’t generate any revenues. Thus we can postulate that line losses are a drain on economic growth in Pakistan. Specifically in the case of Pakistan after conducting a thorough literature review we had come across the energy policy 1994 which laid the foundation for a shift in the energy mix policy of Pakistan’s electricity system, this shift was from the Hydro energy towards thermal powered electricity production units, and this shift also opened up the system for private investment thus paving the way for Independent Power Producers (IPPs) (PPIB 1994). Theoretical literature also indicated that during the early 1990s there was paradigm shift in which many countries liberalized their electricity system but this liberalization did not suit all countries especially the developing countries whose electricity systems were not mature enough to fully reap the benefits of this shift and were not even able to implement this shift fully, thus leading to costly performance problems (Joskow 2006). This has been theorized and studied for some countries but not in the context of Pakistan, the current study postulates for the case of Pakistan that with the introduction of IPPS after the 1994 energy policy of Pakistan, private investors have invested heavily in furnace oil powered electricity production units and this goes against sound long-term electricity planning and causes a drain on economic growth. Within the literature concerning Pakistan we saw that various analytical tools have been utilized to empirically analyze the data of Pakistan and various tools have given different and sometimes conflicting results in causality. Same can be said about the global studies which are presented in table 1 but it has been noted in the end of table 1 that recent studies have employed GMM technique for multivariate data and have yielded similar results. (Sabri Nayan 2013) (Kais Saidi 2015) (Rabia Komal 2015) (Anthony N. Rezitis 2015) (Molem Chirstopher Sama 2016).

The GMM technique is also preferred because this research is aimed at deriving an econometrically testable specification and introduces the methodological approach; as this model and technique addresses various econometric challenges, including endogeneity problems. For the current study the instruments selected are the different sources of electricity production in Pakistan. Since we are employing the instrumental variable approach, that is, to find adequate instruments that are correlated with the endogenous explanatory variable but are not correlated with our dependent variable. As it is difficult to think of appropriate external instruments (M. Arellano 1991), (M. a. Arellano 1995) suggested that in-order to solve the difficulties of empirical growth regressions. The System GMM estimator should be adopted as it does not necessitate the need for any outside instruments but utilizes lagged levels and differences amongst two periods as instruments for current values of the endogenous explanatory variables. The procedure simultaneously estimates a system of equations that consists of both first-differences as well as levels of the estimation equation. Taking first differences eliminates country-specific fixed-effects and solves the problem of time invariant country-specific factors influencing growth. This approach certifies that the study can focus on the impacts from the explanatory variables on economic growth and not vice versa. (Matthias Busse 2012). Based on the literature GMM technique is favored over other techniques, reasons further explanations for the selection of this technique will be provided in detail in the methodology section of this research. We saw that with in the literature almost all the earlier studies engaged co-integration and causality methodologies for the assessment of structural parameters of a single equation model. Co-integration and causality methodologies permit appraisals of connections and relationships over both the long-run and short run periods of time. But we also saw in the literature that the more recent studies globally as well as focusing on Pakistan exhibited the tendency of utilizing the instrument variable techniques like GMM. The present research follows the current trend of analysis and lays emphases on establishing comprehension of the direct effect of Line-Losses in electricity transmission, population through electricity consumption, electricity short fall created through higher demand of electricity as compared to short demand, electricity production through IPPs using oil as a fuel source, and total electricity production on the economic growth network. Instrumental variable estimation method such as the Generalized Method of Moments (GMM) has been utilized to evaluate the parameters. The current approach aims at estimating the structural parameters, at the same time within the evaluation of the structural parameters the economic growth variable is preserved as an endogenous variable while electricity production and is treated as exogenous, and the derived equation for the model is as follows:

$$lnGDP = \beta_0 + \beta_1 Shortfall + \beta_2 lnPopulation + \beta_3 TotalProduction + \beta_4 Linelossess + \beta_5 IPP\_Production + \mu$$

Where on the left hand side we have "lnGDP" which is the real GDP, and on the right hand side we have "β 1 Shortfall" which is electricity short-fall caused by excessive demand and shortage of supply, "β 2 lnPopulation" is the Population of Pakistan,"β 3 TotalProduction" is the total production of electricity, "β 4 Linelossess" represents line losses from electricity transmission, "β 5 IPP_Production" represents electricity production through IPPs using oil as a fuel source and "μ" is stochastic error term. The linkages between these variables and the instruments have been amply explained in the review of the literature section and introduction section presented above.

3. Electricity Crises in Pakistan

According to the data compiled from Pakistan's Hydrocarbon institute of Pakistan the current energy mix till the year 2014 comprised of roughly 89 % Thermal and only 11% renewable. This energy-mix is highly unsustainable because of the massive shares of oil sources and gas sources within this energy mix, as oil is an extremely expensive source of energy, and until the gas pipeline from Iran doesn't get functional producing energy though gas is also not a viable option as throughout Pakistan household heating during the winter season depends heavily on gas. Increasing the share of coal, hydro, and other renewables and at the same time lowering the production from oil is essential to plan for a sound and sustainable energy mix for the country.

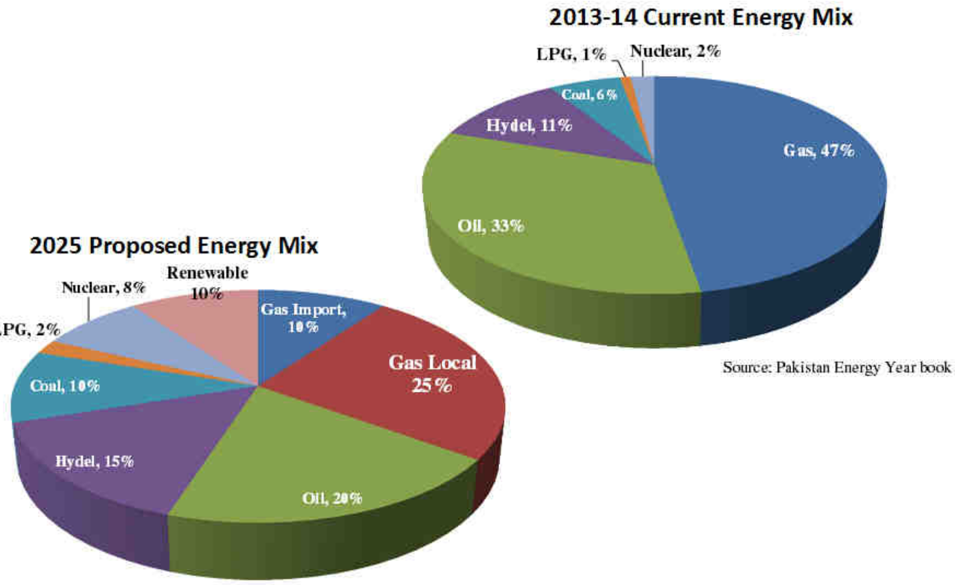

Figure-2. Pakistan's Current Energy-Mix and Proposed Energy-Mix untill 2025 (Source: HDIP, Energy Year Book 2013-2014)

If we look at figure-3 it explains why Pakistan's current energy mix is un-sustainable. As figure 3 shows us that Pakistan is only producing 6% of its electricity from coal while neighboring India is producing 59% of its electricity from coal and the global average for coal powered electricity is 40%, the reason for reliance on producing electricity from coal is because it is a cheap source of fuel to generate electricity. Secondly Pakistan's dependence on burning oil to produce electricity is also very mind boggling because neighboring India it is less than 1% and the global average is merely 4% while Pakistan's reliance on oil stands at 33%. At the same time though Pakistan has natural gas reserves but currently Pakistan is stretching the current reserves and is now resorting to gas imports to produce electricity and the current share of gas as a source to produce electricity in Pakistan is the highest, it stands at a mammoth 47%, while neighboring India's energy mix 2014 from figure-3, tells us that Gas has a mere 9% share and the global figures tell us that the world average is 22%. Though gas is a cheaper source of electricity production as compared to oil, Pakistan needs to diversify its energy mix as it is shown in Government of Pakistan's plans till 2025. Where electricity produced through nuclear power plants is going to gain a share of 8%. Electricity produced through renewable sources like wind and solar will gain considerable traction and will occupy a share of 10%. Gas will be bifurcated in to two accounts, gas imported and gas local adding both the total share of gas would still be considerable standing at 35%. Oil's share would continue to be significant at 20% which is still not a healthy sign. It is calculated that 1,927 kWh electricity is produced per ton of coal consumed and 578 kWh electricity is produced per barrel of oil (EIA 2016). The average delivered coal price to the electric power sector was $45.66 per ton in 2014 (EIA 2014) and the price for one barrel of oil keeps fluctuating and was as high as $98.6 in June 2014 (EIA 2017) thus showing clearly how expensive it is to produce electricity from oil. Electricity produced through coal will occupy 10% of the share which is still less as compared to other countries, and owing to the fact that Pakistan has vast reserves of coal within its own territory. LPG will gain a share of only 2%. Looking at the planned energy-mix and comparing it with India's current energy mix and the global average mix, Pakistan's forecasted and planned mix still seems not very sustainable but it seems like advancements are being planned in the correct direction.

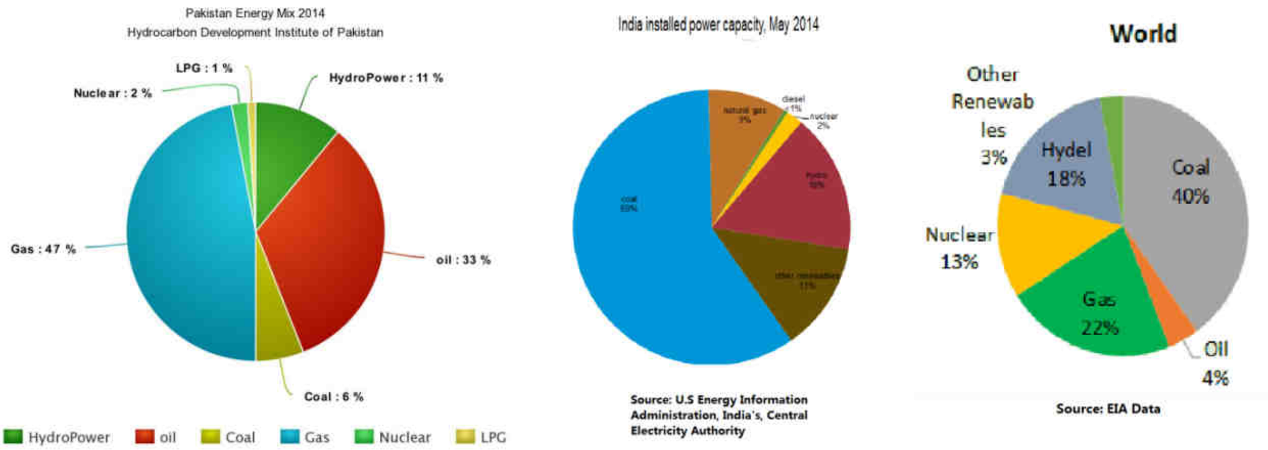

Figure-3. Energy-Mix Comparison of Pakistan, India and the World [Source: (HDIP, Energy Year Book 2013-2014) (Tweed 2014) (EIA 2014)]

4. Variables Data and Methodology

After a careful and thorough review of the literature and the supporting theoretical framework, it was observed that in most of the studies while trying to determining the direction of causality and impacts of electricity consumption and economic growth, total aggregate variables. Example, (A.M.M. Masih 1997) (Al-Iriani 2006) (Alam 2002) (Anjum 2001) (Anthony N. Rezitis 2015) (Kaplan 2011) (M. Rashid 2012) (M. Zeshan 2013) & (Siddique 2004) all utilized total energy consumption data of the subject countries, even for the case of Pakistan most of the studies utilized total energy consumption. This selections seems valid for the global studies, but for the studies focusing on Pakistan, where the focus lies in explaining the electricity crises and its impact on economic growth, the selection of this variable does not seem fully appropriate. Instead the studies focusing on Pakistan should have resorted to using data of electricity consumption rather than utilizing a proxy variable which is "energy consumption". "Energy consumption" incorporates; the usage of oil, gas and other fuels for all purposes like in the transportation sector, industrial sector and households e.t.c. Though the variable energy consumption also incorporates electricity consumption, but it is only a fraction of the entire variable, thus this inadequate selection of variables might be one of the causes behind the anomaly of the mixed results from the various studies conducted on Pakistan's case. That is why for the current study, data and variables were selected very carefully.

For measuring electricity and its various sources, the variables selected were; Total Electricity Production, Electricity Produced from Gas, Electricity Produced from Hydro-Sources, Electricity Produced from Oil, Electricity Produced from Nuclear Plants, Electricity Produced from Coal, Electricity Short Fall, Total Electricity Consumption, Line Losses through Transmission, Electricity Produced through IPPs and Total Population over the years was selected as an input and the independent variable selected was Pakistan's GDP. An overview of all these variables is presented in table-3.

Table-3. Names, definitions, sources and expected signs of variables.

Variables (Measurement)	**Definition (Sign)**	**Source**
Electricity Consumption (GWh)	Total Electricity Net Consumption = total net electricity generation + electricity imports - electricity exports – electricity transmission and distribution losses. Net consumption excludes the energy consumed by the generating units. Annually **(Positive)**	HDIP
Electricity Production (Gwh)	Total electricity net generation (Net generation excludes the energy consumed by the generating units) Annually. **(Positive)**	HDIP
Electricity Production Through Gas (GWh)	Total electricity through power plants using natural gas as a fuel source net generation (Net generation excludes the energy consumed by the generating units) Annually.**(Positive)**	HDIP
Total Hydroelectricity generation (GWh)	Hydroelectric generation excludes generation from hydroelectric pumped storage. Annually.**(Positive)**	HDIP
Electricity Produced through Oil (GWh)	Total electricity through power plants using natural oil/diesel as a fuel source net generation (Net generation excludes the energy consumed by the generating units) **(Positive)**	HDIP
Nuclear power generation (GWh)	Nuclear electricity net generation (Net generation excludes the energy consumed by the generating units) annually. **(Positive)**	HDIP
Electricity Produced from Coal (GWh)	Total electricity through power plants using natural oil/diesel as a fuel source net generation (Net generation excludes the energy consumed by the generating units) annually. **(Positive)**	HDIP
Electricity Short Fall (GWh)	A condition that occurs in an electric power system when the total real or reactive power of the power plants in the system is insufficient to supply all consumers with electric power of the required quality. This is calculated by subtracting the data for electricity demand from supply. **(Negative)**	Computed by Author through data from HDIP
Line Losses (GWh)	As electricity travels through power lines, a proportion of energy is lost as heat due to the resistance in the lines.this loss of electricity through transmission is called Line losses. **(Negative)**	HDIP
Electricity Produced through IPPs (GWh)	Total electricity through Independent Power Plants (Privately owned) net generation. (Net generation excludes the energy consumed by the generating units) Annually. **(Negative)**	HDIP
Real GDP ($US)	Real Gross Domestic Product (real GDP) is a macroeconomic measure of the value of economic output adjusted for price changes (i.e., inflation or deflation).**(Positive)**	WDI
Total Population	Number of People with in the country. **(Positive)**	WDI
Sources: (HDIP 2014) (HDIP, Energy Year Book 1990-91) (HDIP, Energy Year Book 1992-93) (HDIP, Energy Year Book 1993-94) (HDIP, Energy Year Book 1995-96) (HDIP, Energy Year Book 1997-98) (HDIP, Energy Year Book 1999-200) (HDIP, Energy Year Book 2001-02) (HDIP, Energy Year Book 2003-04) (HDIP, Energy Year Book 2005-06) (HDIP, Energy Year Book 2007-08) (HDIP, Energy Year Book 2009-10) (HDIP, Energy Year Book 2011-12) (HDIP, Energy Year Book 2013-2014) (WDI 2016)		

4.1 Hypothesis

From the literature we have gathered that once the production of a country increases, the demand for energy within that country also increases, as electricity is a major input for production. With the occurrence of this phenomenon we can extrapolate that energy demand rises with the increase in production. But this doesn't occurs when economic growth transpires in the presence of an energy efficient environment, where the equipment for production activities, and the infrastructure in place is energy efficient (Islam F 2013). But for our case we know that in Pakistan neither the equipment within the industries, households nor the electricity infrastructure is efficient, otherwise massive line losses amounting to 25-34% of the total electricity production would not occur. Thus it is safe to postulate that in Pakistan rise in production activities entails rise in electricity demanded. We know that rise in population also triggers the rise in demand for electricity and Pakistan's population growth rate in 2015 was 2.075% (IBRD 2015). Which is very high (Jones 1991). Since Pakistan's houses a growing population, with mounting energy demand to fulfill the needs of industry, households and commercial activities, the growth of the economy is also being hindered due to this phenomenon as explained by (Imran Naseem 2015). It has been explained in studies that liberalization of the electricity sector when not managed properly lead to structural problems and raises the risk of deep rooted problems (Beder 2005), it is postulated that the induction of IPPs into the electricity system of Pakistan was not thought out properly and long-term effects of this introduction of IPPs depending upon oil as a fuel source were not adequately planned for and are thus a cause for the hindering economic growth within Pakistan. **As** mentioned above the literature has provided us with mixed results concerning the causality between the under study variables. We have been able to gather from the literature that in the presence of unidirectional causality running from energy consumption to economic growth, then in that case the country is considered as highly energy reliant which translates to the fact that the country desperately needs energy to exhibit economic growth. This phenomenon is called that "Growth Hypothesis" (Saatci 2013)**.** It was also observed from the literature that in the presence of bi-directional causality between the variables it can be extrapolated that the variables are complementary in nature and this phenomenon has been termed as "feedback hypothesi**s"** (Apergis 2009). The other phenomena highlighted by the literature were, that in the absence of causality then it is called "Neutrality Hypothesis" (Cheng 1999). In the event of getting results that highlight the fact that economic growth triggers energy consumption, then in that case it is called the "conservation hypothesis" which explains that energy consumption will increase in due course of time as economic growth swells (Lise 2007). To summarize the state of affairs related to electricity in Pakistan, we can see that Pakistan has been entrenched in an electricity crisis for over a decade, the reasons for this prolonged issue are the inefficient and short term focused policies to raise capacity, unproductive utilization of hydro and coal resources, inept consumption of energy and renewable resources. All these have led to a massive shortfall in demand and supply of electricity.

H_{01} "As the population of Pakistan grows this positively impacts the GDP of Pakistan."

H 1a "As the population of Pakistan grows this has no impact on the GDP of Pakistan."

H 1b "As the population of Pakistan grows this has negative impacts on the GDP of Pakistan."

H 02= "Electricity Short-fall created by high demand and less supply; has negative impacts on the real GDP of Pakistan"

H 2a = "Electricity Short-fall created by high demand and less supply; has no impacts on the real GDP of Pakistan"

H 2b = "Electricity Short-fall created by high demand and less supply; has positive impacts on the real GDP of Pakistan"

$H\ 0_{3=}$ "Rise in electricity production of Pakistan positively impacts the GDP of Pakistan."

H 3a= "Rise in electricity production of Pakistan negatively impacts the GDP of Pakistan."

H 3b= "Rise in electricity production of Pakistan has no impacts on the GDP of Pakistan."

$H_{04=}$ "Line-losses resulting from electricity transmission negatively impact the GDP of Pakistan."

H 4a= "Line-losses resulting from electricity transmission positively impact the GDP of Pakistan."

H 4b= "Line-losses resulting from electricity transmission have no impacts on the GDP of Pakistan."

$H_{05=}$ "Escalation in electricity production through IPPs using oil sources of fuel negatively impact the GDP of Pakistan."

H 5a= "Escalation in electricity production through IPPs using oil sources of fuel positively impact the GDP of Pakistan."

H 5b= "Escalation in electricity production through IPPs using oil sources of fuel has no impact on the GDP of Pakistan."

4.2 Data Collection

The current research employs annual time series data of Pakistan for the time period ranging from 1991 to 2014. Data for total Electricity Production, Electricity Produced from Gas, Electricity Produced from Hydro-Sources, Electricity Produced from Oil, Electricity Produced from Nuclear Plants, Electricity Produced from Coal, Electricity Short Fall, Electricity, Total Electricity Consumption, Line Losses through Transmission, Electricity Produced through IPPs was gathered from the various issues published by the Hydrocarbon Development Institute of Pakistan. Data for Pakistan's population over the years was taken the World Bank's World Development Indicators and cross checked with Pakistan Economic Survey's various issues. Real GDP data measured in US dollars was also collected from the World Bank's World Development Indicators and cross checked with various issues of Pakistan's Economic Survey.

4.3 Methodology

The present research follows the current trend of analysis and lays emphases on establishing comprehension of the direct effect of Line-Losses in electricity transmission, population through electricity consumption, electricity short fall created through higher demand of electricity as compared to short demand, electricity production through IPPs using oil as a fuel source, and total electricity production on the economic growth network. Instrumental variable estimation method such as the Generalized Method of Moments (GMM) has been utilized to evaluate the parameters. The current approach aims at estimating the structural parameters, at the same time within the evaluation of the structural parameters the economic growth variable is preserved as an endogenous variable while electricity production and is treated as exogenous. The problem with ordinary least square (OLS) methods of regression is that they have a tendency of creating a scenario where endogenous variables and disturbances are reciprocally correlated in concurrent equation models thus yielding results plagued by unintentional simultaneity or endogeneity biases, this leads to biased and inconsistent parameter estimation. Thus it can be said that the OLS technique has a tendency for allowing the disregard for one of the prime conventions of the classical linear regression model (CLRM). Nonetheless, if we employ the use of approximation techniques that encompass instrumental variables will form the basis of obtaining reliable, balanced, impartial and unbiased parameter estimates. This provision of unbiased parameter estimates is based on the fact that the use of instrumental variables ensure the provision of variables that are correlated with independent variables of the equation at the same time they are uncorrelated with disturbances, thus the use of instruments eradicates the correlation between independent variables and disturbance, and in this process much reliable results and approximations can be achieved. The GMM technique can be used in two distinct ways, both as a technique of estimation for a single equation as well as for deriving estimations for a system. This method holds favor over other techniques belonging to the same category and class because of 4 major reasons. The first reason is that the GMM provides an easily comprehensible auxiliary as compared to other similar techniques, predominantly when problems and issues arise while explaining the maximum likelihood estimator. The second reason is that the GMM assimilates numerous standard estimators; therefore its offerings include the much needed framework for the assessment and comparison of the estimators. The third reason for the GMM gaining favor is that it is a robust estimator as it doesn't necessitate evidence regarding accurate distribution of error terms. The fourth and final reason why the GMM technique is preferred is because it approaches a values or curves arbitrarily closely or in other words it is asymptotically unbiased and a reliable estimator irrespective of weighting matrix used (Manuel Arellano 1991) (M. Arellano 1993).

5. Result Analysis and Findings

Table-4 which captures the results of the Cragg-Donald test, which we utilized to test the validity of the instruments, we also used this test to avoid any misgivings caused by this phenomenon of asymptotic presence within this research. To test the null hypothesis of under identification (J.G. Cragg 1993) developed this test, and from the results of this test if we look at Cragg-Donald F-stat value. It is registered at 1.986156 which indicates that Cragg-Donald test for over identification shows that the instruments are valid and strictly exogenous.

Table 4. Cragg-Donald Test

Weak Instrument Diagnostics		
Equation:		
Cragg-Donald F-stat:	1.986156	
Stock-Yogo TSLS critical values (relative bias):		
5%	12.20	
10%	7.77	
20%	5.35	
30%	4.40	
Stock-Yogo size critical values not available for models with more than 2 endogenous variables.		
Moment selection criteria:		
SIC-based:	-4.116031	
HQIC-based:	-1.845068	
Relevant MSC:	-8.569739	

The results from table-5 show us that the Overall model is fit for the test; as the Durbin-Watson stat stands at 1.194

which is acceptable. It is seen that population “POPU” is estimated to be 2.38, Electricity short-fall “NEG-FALL” estimated to be 0.21, total production of electricity “TOTAL_PROD” estimated to be 1.5, Line losses “LIN2_LOSS” estimated to be 3.26, and production through IPPs “PROD_IPP” estimated at 0.4; all are significantly different than zero at *P*-values of less than 2%. The *J*-statistic that is distributed as $\chi 2$ with one degree of freedom is 4.5 with a *P*-value of 0.207. Which proves that the moment restrictions applied by the model and the rational expectations are not rejected.

Table 5. GMM Estimates

Dependent Variable: GDP
Method: Generalized Method of Moments
Date: 10/10/16 Time: 07:42
Sample (adjusted): 1997 2014
Included observations: 18 after adjustments
Linear estimation with 1 weight update
Estimation weighting matrix: HAC (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)
Standard errors & covariance computed using estimation weighting matrix
Instrument specification: GDP POPU NEG_FALL OIL_PROD GAS_PROD HYD_PROD COAL_PROD NUC_PROD
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-12.81614	4.198340	-3.052668	0.0100
POPU	2.378392	0.600574	3.960197	0.0019
NEG_FALL	-0.216019	0.082085	-2.631652	0.0219
TOTAL_PROD	1.480031	0.451101	3.280928	0.0066
LIN2_LOSS	-3.269220	2.500759	-1.307291	0.2156
PROD_IPP	-0.402194	0.101388	-3.966890	0.0019

R-squared	0.989898	Mean dependent var	11.07735
Adjusted R-squared	0.985689	S.D. dependent var	0.219729
S.E. of regression	0.026286	Sum squared resid	0.008292
Durbin-Watson stat	1.193804	J-statistic	4.555085
Instrument rank	9	Prob(J-statistic)	0.207429

Results:

1. GMM estimations accept the null hypothesis that electricity short fall seriously hindering the economic development of Pakistan.
2. GMM estimations accept the null hypothesis that Population growth has a positive impact on real GDP.
3. GMM estimations accept the null hypothesis that increase in total electricity production/Consumption has a positive impact on GDP
4. GMM estimations accept the null hypothesis that line-losses through transmission have a negative impact on real GDP of Pakistan.
5. GMM estimations accept the null hypothesis that electricity production through IPPs using oil as a fuel source has negative impacts on the real GDP of Pakistan.

The above mentioned null hypotheses have been accepted because:

From table-5 we can see that:

1. The elasticity of coefficient of population shows that 1% change triggers a 2.37% change in real GDP.
2. The elasticity of coefficient of electricity short-fall shows that 1% change triggers a -0.21% change in real GDP.
3. The elasticity of coefficient of electricity production/consumption shows that 1% change triggers a 1.48% change in real GDP.
4. The elasticity of coefficient of line losses through electricity transmission shows that 1% change triggers a -3.27% change in real GDP.
5. The elasticity of coefficient of electricity production through IPPs using oil as a fuel source shows that 1% change triggers a -0.4% change in real GDP.

5.1 Robustness Check

Robustness test was also conducted using the GMM technique to check for structural break. The GMM robustness test for this study was conducted in two different time periods, because it was witnessed in the literature that, over the course of time in Pakistan, the energy-mix of Pakistan has gone through various shifts, and the time period selected for this study was from 1991-2014 and during this time two separate shifts within the energy mix had occurred. Table-6 highlights the results from 1997-2011 and table-7 highlights the results gained from the years 2000-2014.

The results from table-6 show us that the Overall model is fit for the test as the Durbin-Watson stat stands at 1.351 which is acceptable. It is seen that population “POPU” is estimated to be 1.61, Electricity short-fall “NEG-FALL” estimated to be 0.24, total production of electricity “TOTAL_PROD” estimated to be 1.7, Line losses “LIN2_LOSS” estimated to be 3.51, and production through IPPs “PROD_IPP” estimated at 0.3; all are significantly different than zero at P-values of less than 2%. The J-statistic that is distributed as $\chi 2$ with one degree of freedom is 3.7 with a P-value of 0.284. Which proves that the moment restrictions applied by the model and the rational expectations are not rejected.

Table 6. GMM Robustness Check-1

Dependent Variable: GDP
Method: Generalized Method of Moments
Date: 10/10/16 Time: 09:34
Sample: 1997 2011
Included observations: 15
Linear estimation with 1 weight update
Estimation weighting matrix: HAC (Bartlett kernel, Newey-West fixed
bandwidth = 3.0000)
Standard errors & covariance computed using estimation weighting matrix
Instrument specification: GDP POPU NEG_FALL OIL_PROD GAS_PROD
HYD_PROD COAL_PROD NUC_PROD
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-7.807900	3.616105	-2.159201	0.0591
POPU	1.612213	0.530010	3.041856	0.0140
NEG_FALL	-0.247479	0.066817	-3.703821	0.0049
TOTAL_PROD	1.676620	0.197810	8.475915	0.0000
LIN2_LOSS	-3.512317	1.641857	-2.139234	0.0611
PROD_IPP	-0.332854	0.133779	-2.488094	0.0345

R-squared	0.987373	Mean dependent var	11.01882
Adjusted R-squared	0.980359	S.D. dependent var	0.191160
S.E. of regression	0.026791	Sum squared resid	0.006460
Durbin-Watson stat	1.351789	J-statistic	3.791029
Instrument rank	9	Prob(J-statistic)	0.284931

Results table-6:

1. GMM estimations accept the null hypothesis that electricity short fall seriously hindering the economic development of Pakistan.
2. GMM estimations accept the null hypothesis that Population growth has a positive impact on real GDP.
3. GMM estimations accept the null hypothesis that increase in total electricity production/Consumption has a positive impact on GDP
4. GMM estimations accept the null hypothesis that line-losses through transmission have a negative impact on real GDP of Pakistan.
5. GMM estimations accept the null hypothesis that electricity production through IPPs using oil as a fuel source has negative impacts on the real GDP of Pakistan.

The above mentioned null hypotheses have been accepted because:

From table-6 we can see that:

1. The elasticity of coefficient of population shows that 1% change triggers a 1.61% change in real GDP.
2. The elasticity of coefficient of electricity short-fall shows that 1% change triggers a -0.24% change in real GDP.
3. The elasticity of coefficient of electricity production/consumption shows that 1% change triggers a 1.7% change in real GDP.
4. The elasticity of coefficient of line losses through electricity transmission shows that 1% change triggers a -3.5% change in real GDP.
5. The elasticity of coefficient of electricity production through IPPs using oil as a fuel source shows that 1% change triggers a -0.3% change in real GDP.

The results from table-7 show us that the Overall model is fit for the test as the Durbin-Watson stat stands at 1.526 which is acceptable. It is seen that population “POPU” is estimated to be 1.14, Electricity short-fall “NEG-FALL” estimated to be 0.29, total production of electricity “TOTAL_PROD” estimated to be 2.23, Line losses “LIN2_LOSS” estimated to be 7.76, and production through IPPs “PROD_IPP” estimated at 0.63; all are significantly different than zero at P-values of less than 2%. The J-statistic that is distributed as $\chi 2$ with one degree of freedom is 4.6 with a P-value of 0.199. Which proves that the moment restrictions applied by the model and the rational expectations are not rejected.

Results table-7:

1. GMM estimations accept the null hypothesis that electricity short fall seriously hindering the economic development of Pakistan.
2. GMM estimations accept the null hypothesis that Population growth has a positive impact on real GDP.
3. GMM estimations accept the null hypothesis that increase in total electricity production/Consumption has a positive impact on GDP
4. GMM estimations accept the null hypothesis that line-losses through transmission have a negative impact on real GDP of Pakistan.
5. GMM estimations accept the null hypothesis that electricity production through IPPs using oil as a fuel source has negative impacts on the real GDP of Pakistan.

The above mentioned null hypotheses have been accepted because:

From table-7 we can see that:

1. The elasticity of coefficient of population shows that 1% change triggers a 1.14% change in real GDP.
2. The elasticity of coefficient of electricity short-fall shows that 1% change triggers a -0.29% change in real GDP.
3. The elasticity of coefficient of electricity production/consumption shows that 1% change triggers a 2.23% change in real GDP.
4. The elasticity of coefficient of line losses through electricity transmission shows that 1% change triggers a -7.76% change in real GDP.

5. The elasticity of coefficient of electricity production through IPPs using oil as a fuel source shows that 1% change triggers a -0.63% change in real GDP.

Table 7. GMM Robustness Check-2

Dependent Variable: GDP
Method: Generalized Method of Moments
Date: 10/10/16 Time: 09:35
Sample: 2000 2014
Included observations: 15
Linear estimation with 1 weight update
Estimation weighting matrix: HAC (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)
Standard errors & covariance computed using estimation weighting matrix
Instrument specification: GDP POPU NEG_FALL OIL_PROD GAS_PROD HYD_PROD COAL_PROD NUC_PROD
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.924363	4.096503	-0.713868	0.4934
POPU	1.147870	0.568337	2.019700	0.0742
NEG_FALL	-0.294746	0.113790	-2.590270	0.0292
TOTAL_PROD	2.230635	0.339331	6.573634	0.0001
LIN2_LOSS	-7.765702	1.314529	-5.907593	0.0002
PROD_IPP	-0.632196	0.315236	-2.005470	0.0759

R-squared	0.990568	Mean dependent var	11.13360
Adjusted R-squared	0.985327	S.D. dependent var	0.195668
S.E. of regression	0.023702	Sum squared resid	0.005056
Durbin-Watson stat	1.526447	J-statistic	4.644502
Instrument rank	9	Prob(J-statistic)	0.199758

6. Conclusion and Recommendations

The scarcity of electric power in Pakistan, the usage of expensive energy fuels to generate electricity coupled with mismanagement and the lack of political will to introduce reforms with in the electricity sector of Pakistan has incurred high economic costs and in return have proven to be very damaging for the economy of Pakistan. It has been observed that Pakistan on its own lacks the requisite finances needed to be mobilized to curtail the electricity crisis in Pakistan, thus requires foreign investment and reforms, it has been observed that China has offered to help fill this gap of the much needed finances required by the government of Pakistan, through China's investment plans under the umbrella of the China Pakistan Economic Corridor (CPEC). Through this research it has been observed that sound planning is further required by the government of Pakistan to manage the investments by China and to attract further investments from other countries to open up the energy sector of Pakistan through reforms. The Chinese vision of One Belt One Road (OBOR) has been perceived by Chinese planners and their well-wishers as a game changer for the entire region and beyond. While the CPEC will be a harbinger of economic prosperity and well-being for Pakistan, China and the neighboring states. (Shafei Moiz Hali 2015) Pakistan needs to channel this investment from China in a fashion favorable for Pakistan. This study has pointed out that the reforms also have to be planned adequately and need to be transparent and allow the market forces to play their role, rather than resorting corrupt means to achieving high asset returns and resultantly exacerbating the existing problems within the electricity sector of Pakistan.

This study has revealed that though Pakistan needs to increase its electricity generation capacity and lower its dependence on oil as an electricity fuel source but it has to be noted that this process is a long-term measure and in the short-term Pakistan needs to upgrade and better manage the existing system, by making investments in technology and skills, rather than solely depending on China to invest in electricity production projects and wishing away the inherent problems within the existing system for long-term streamlined solutions of the energy crisis.

6.1 Policy Recommendations

In order to develop sound sustainable policy recommendations for the policy makers in Pakistan a thorough study of literature was conducted and from the literature, variables were identified, for which a painstaking job of collecting data was conducted. The data in Pakistan is very unreliable and getting data from even the public organizations and institutions is not an easy task owing to bureaucratic hurdles. Once the data was collected, it was compared with other sources of data to disregard anomalies within the data, then based on contemporary trends and literature review; a research model was developed to analyze the data, from the data analysis H01, H02, H03, H04 and H05 were the hypotheses which were accepted and then after exploring the literature qualitatively the association of the empirical results with the qualitative data was done to fully understand the energy crisis in Pakistan, through this comprehension the following guidelines were determined for recommending policy options and policies which can prove to be useful for the energy policy makers in Pakistan.

Table 8. Guidelines for Government Policies for maintaining equity for Foreign Investors in the Power Sector of Pakistan (Source: Grewer 2015)

Government	**Equity Investor/Developer**
Cost-effective generation capacity that can be rapidly deployed and scaled to decrease the supply-demand gap	Commitment from the government regarding the off-take of power at an agreed-upon-price for the duration of the project; timely payment of receivables.
Power generated by low-cost fuels, with a preference for domestic fuels.	Availability of fuel at a fixed cost.
Increased efficiencies to boost capacity while generating lower cost power	Transparency and streamlined processes at the ministries and the regulator to reduce project delays and minimize disputes
Minimal investment required for infrastructure improvements	Guaranteed evacuation of power at no additional cost to the developer
Associated revenue through taxes.	Tax incentives to reduce project costs guaranteed for project duration.
Reduced environmental impact	Protection from changes in law that can increase project costs.
	Protection from currency devaluation.
	Ability to repatriate dividends.

- **The Policy Makers Should Accentuate Demand Driven Solutions as much as the Supply Enhancement Solutions**

It would be prudent to set up a policy framework which supports and compels the energy users to resort to the utilization of energy efficient technologies; thus lowering demand as is the case in many developed countries. This also means the modernization of the existing electricity system and electricity generation plants in Pakistan, which will benefit the country in the long-run.

- **Implementation and employment of Local Think Tanks to Generate Better Policy Option Plans**

It has been observed that, when it comes to making policies regarding electricity in Pakistan, it is usually ill-informed, short-term and not sustainable. Evidences of this phenomenon have been amply discussed in this study and because of the periodic occurrence of these planning issues, this research suggests that, the government of Pakistan should share data with think-tanks locally or internationally to generate sustainable policy alternatives for Pakistan’s energy sector.

- **Assigning Significance to Non-Commercial Energy Fuel Sources in Pakistan**

Though this research has not covered this topic, but during the literature review it was uncovered that in Pakistan much of the population lives in the rural areas. In the rural areas of Pakistan, non-commercial sources of energy are widely used as fuels to sustain daily life. Thus it will not be difficult in setting up plants in the rural areas which produce electricity using biomass.

- **Learning from the Experiences of Other Countries**

Pakistan is not the only country which has suffered from extreme energy crisis in the world. Though this point has not been amply explained in the research but during the literature review concerning transmission and distribution losses, it was uncovered that other countries like Kazakhstan were also suffering from severe energy crisis and have been able to come out on top by seriously reforming and upgrading their infrastructure step by step and through careful planning. Pakistan can learn from their mistakes and successes and also use the lessons learnt as policy guidelines for the future.

- **Pakistan Energy Mix needs to be Balanced and made Cheap**

This point has not only been proven empirically but also qualitatively in the current study and it has been noted that the utilization of oil as a fuel source for the production of electricity is extremely detrimental for the economic growth of Pakistan. The policy makers in the country need to urgently restructure the energy policy to cut down the use of oil as a fuel source for electricity production and balance this out with other more efficient and cheaper fuel sources which are available.

- **Enhancement of Utilization of Coal for Electricity Production**

It has been observed that despite importance being given to this fuel as a source of electricity production as is evident by the amounts of Chinese investments in developing coal power plants in Pakistan, but the future energy plans of Pakistan still highlight that coal would not occupy the share it needs. It has also been identified in this research that very little Chinese investment is targeting Pakistan's own coal reserves for electricity production. The policy makers in Pakistan need to address this issue, either by diverting domestic resources or by gaining further foreign investments to capitalize upon the local coal reserves of Pakistan for further electricity generation.

- **Enhancing the use of Contemporary Renewable Energy Sources in to the fold of the Energy Mix**.

As the world is facing the challenges stemming from global warming and all international institutions are gearing up in highlighting this phenomenon. In the future Co2 emission restrictions will be cast on countries to reduce their carbon footprint; Pakistan needs to plan ahead for the future by investing today in projects using these forms of energy. This will be extremely beneficial for Pakistan in the long-run, especially because in the literature it was observed that Pakistan has considerable potential for the employment of these sources of electricity.

- **Need for Lowering Transmission and Distribution Losses**

It had been highlighted in this study the success story of KESC, how privatization and intelligent planning has helped one of the 9 distribution companies and in fact the only private distribution company to overcome these losses. Lessons from this success story need to be drawn by the policy makers in Pakistan and further reformation of the system needs implementation.

- **Deepen Measures to Establish a Culture of Energy Conservation**

Though Policy makers have spent considerable amounts of money on public education campaigns for electricity conservation but it has had little effect. The government should now focus on a reward based system through the billing system; which rewards electricity customers and users who conserve energy. This method is proven to have better results as compared to only spending money on public education campaigns.

- **Bringing the Energy Sector of Pakistan under a Single Managing Authority**

It has been observed that much time and energy is wasted in Pakistan's electricity sector due to lack of coordination and delays in communication. It has also been observed that Pakistan's public electricity sector institutions are separate and independent. In-order to bring successful reforms step by step, in an efficient manner; The decision making needs to come under a single well informed institution, and thus it is advised that Pakistan's energy sector needs to be handled by a single ministry to reduce decision delays and to streamline the reform process.

6.2 Limitations of the Study

The current study has some limitations because in order to understand the energy crisis in Pakistan this study employed the use of empirical analysis of a few aspects of the crisis not all the aspects and the absence of empirical backing of the remaining aspects of the crisis, qualitative research was done to bridge this gap, had all the aspects been studied then it would have contributed more towards the literature, these short comings provide room for future research.

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