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The Determinants and Forecasting of Electricity Supply in Pakistan (1972-2014)

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Abstract
Development of Today's world is impossible without the presence of required energy supply especially electricity in developing countries. Electricity is one of the most important forms of energy and its use increasing progressively with time. Pakistan faces sever electricity crises in the last two decades more specifically after the year 2000, which effect different sectors of the economy like agricultural, industrial and the services sectors. In recent years Pakistan commenced many projects to enhance electricity supply but failed to achieve the required target. This is due to fiscal mismanagement and policy inefficiency. To overcome the problem of electricity shortfall government and policy makers should to recognize the determinants of electricity generation and to accurately forecast electricity supply. The present study focused on the determinants of electricity supply from 1972-2014, followed by forecasting of electricity supply up to 2025. The study use OLS econometric technique to point out the determinants and ARIMA technique is used for forecasting electricity supply. Results showed that total petroleum import, electricity transmission and distribution loss, price of petroleum and technology were statistically significant, while rainfall and electricity price were statistically insignificant determinants of electricity supply. Moreover price elasticity of electricity is inelastic. The finding of the study suggests that government and private sectors should inject more funds to energy particularly electricity sector in favor of technology and to increase electricity supply to meet increasing demands of energy.
Keywords: Electricity, Determinants, Forecasting, ARIMA, Pakistan**.**

1. Introduction

Energy occupies a significant place in persistent growth and sustainable economic development of a country. Contemporary research suggests energy, the life blood that for economic development of developing countries (IEA, 2005). However, the discovery and explorations of various energy sources provide employment opportunities and also improve economic conditions and fulfill the requirements of industrial, agricultural, transportation and commercial sectors development of the economy. The availability of energy resources in the country reduces the imports bill of many items such as oil, electricity and chemicals etc. The energy sector thus makes a significant contribution to GDP (Odalaru, 2009). Starr and Field (1979) were of the view that energy availability is matter of concerned for USA economy. They focused energy in relation to economic progress. While domestic supply of energy has decreased rapidly during 1960's. The scarcity of domestic inexpensive energy resources were begun to hamper the future social and economic development. Efficient planning needed to increase energy supply to avoid energy deficiencies. The study found that energy supply has positive effect on economic growth and employment. Energy crisis is one of the most important challenges to industrial, agricultural and services sector.

Pelesai (2013) compared the electricity demand and supply in Nigeria. The reduced form model and VECM approach were used in the study. The results of the study illustrated that both price of electricity and income of the consumers has elastic demand, as any increment in electricity price will reduced revenue generation for Power Company. Further the study found a gap between electricity demand and supply due to deficiencies in electricity production. Current study also demonstrated that Nigeria power sector associated with diseconomies of scale as outcome inadequacy occur to innovation in order to enhance power generation at lowest cost. The study suggested that government and policy makers must take effective measures to overcome the problems of inability and lack of innovation to minimize wastage of resources and boost electricity supply to insure not only economic growth but to generate handsome revenue for government for improvement in infrastructure to achieve overall economic development.

Ubi (2012) the study recognized that lack of electricity supply has main obstacle to industrial and economic development in Nigeria. The government has started a numbers of projects to increase electricity supply but has failed to achieve the targets, because due to inefficiency of policy makers to acknowledge the proper determinants of electricity supply for policy implementation. This study used different econometrics method of co-integration, stationary test and ordinary least square for analysis of time series data from 1970-2009. The regression model states that electricity supply is depended on government funding, price per Mega

watt, rainfall, technology and quantity of power loss. The OLS results illustrated that power loss; government funding and technology were key and statistically significant determinants of electricity supply. While electricity price has positive but statistically insignificant effect on electricity supply at 5 % level of significance. The study suggests that the government should insert more funds to introduce modern technology to complete the existing projects and initiated new projects in order to increase electricity supply.

Erdogdu (2010) has analyzed that the Turkey energy demand on average basis increased by 8% annually, while natural gas demand has increased faster than other energy components in Turkey. The study estimated the short run and long run price and income elasticity of gas consumption on sector basis. The gas consumption was forecasted by using ARIMA model. He found that the gas demand has highly inelastic to price and income, and also the estimated results were statistically insignificant. Price inelastic gas demand showed little response to change in price. The study proposed market deregulation needed in Turkey gas market. The present forecast was not over or under estimate natural gas consumption while past official forecast was over estimated.

Pao (2009) showed the causality between electricity utilization and GDP. The study illustrated that real GDP and electricity consumption were co-integrated. There was unidirectional causality from economic growth to electricity consumption in both short and long run as well, but not vice versa. Different models were used to forecast electricity consumption in Taiwan; amongst these methods the SARIMA model was best to forecast electricity consumption in short period.

Okafar (2008) studied that the power crisis has vast effect on industrial infrastructure of Nigeria. Technological infrastructure has important for industrialization, economic growth and technological progress. Technological infrastructure consists of energy, power supply, transport and communication etc but this study relay mainly on power supply. Further this study examined that the government allocate massive fund to power sector in 1999 to 2007 was produce almost 3000 MW electricity despite the requirement of 10000 MW. This scarcity of electricity supply has severely affect industrial sector of Nigeria. The study recommended that on urgent basis renovate the overall power sector of Nigeria to insure the industrial and economic development in the country.

Sambo (2008) has examined and counterpart energy supply with demand in Nigeria. The expected electricity demand was calculated. The key determinants of energy demand were economic growth, population and technology. Out of which GDP and structure of economy were dominant factors. The electricity supply stratagem depends on the expected electricity demand as a factor. The projected 484.62 b dollars of total investment required to meet the energy demand for buoyant growth. The government might not afford that much height of funding separately, along with Govt, private sectors and foreign direct investment have to engage. Further the domestic resources of energy should be utilized in order to equate energy supply with demand on retinue basis in the country.

Subair (2008) assessed the importance of electricity for infrastructure, socio economic conditions, transport, communication, construction, standard of living and ultimate economic growth and development. Results of the study showed that there was no co-integration found amongst variables, consequently short run dynamic model has used as suitable model. The electricity consumption depends on electricity production, Per Capita Income and price. All variables in line with theory but income have statistically insignificant effect on electricity consumption; further income and price have inelastic demand. Due to privatization and commercialization and no intervention of government to regulate prices the consumption of electricity will reduce mostly. At last the study suggested that more licenses should be provided to private sectors in order to increase supply of electricity from available resources.

Erdogdu (2007) examined the effects of modification in liberalization and privatization in electricity market for Turkey economy. The rationales behind those reforms were rapidly increasing electricity demand and eventually energy crises. This paper estimated and forecast electricity demand by using regression and ARIMA models. The results of the study indicated that income and price elasticity were inelastic require economic regulation in the electricity market, moreover the official forecast projected high demand of electricity then estimated forecast obtain from ARIMA model.

Zhao and Wu (2007) used co-integration and VECM techniques. The study evaluated that China energy imports promote due to persistent economic growth. China has inelastic import of oil irrespective of world oil price because of scarce domestic energy resources and high domestic production cost of oil. The China internal oil production has least substitution effect on import due to industry and automotive sectors growth. Lledare (1995) also suggests effective policies in shape of incentives and relaxation to increase supply of natural energy.

2. Pakistan's Energy Status

Energy sector infrastructure in Pakistan is not well developed, somehow it is considered to be inadequately managed. Currently Pakistan is facing severe energy crisis. Despite of achieving considerable economic growth and growing demand for energy during past two decades, no serious steps have been taken in favor of energy

generation. Furthermore, power theft, transmission losses due to inadequate and outdated infrastructure and reductions in hydropower have worsened the situation. Thereafter, the diversion between demand and supply (Demand exceeds supply) leads to load-shedding. It becomes a common phenomenon through power shutdown. At the time of independence, Pakistan had the capacity of 60MW of power generation which had enjoyed by about 31.5 million people, producing 4.5 units per capita consumption. WAPDA was launched after twelve years of independence in 1959; the generation capacity had increased to 119 MW in 1964-65. Furthermore the electricity generation capability increased from 119MW to 636 MW during the same period. The rapid growth in energy brought social and structural changes to life, mechanization in agriculture sector started, industrialization picked up and general living standards improved. In 1980s, 86% of the total energy demand in Pakistan was satisfied from domestic energy supply, and the remaining 14% of energy requirement was managed by imports, while this gap reached to about 47% at the end of 2000 (SBP, 2006). 1990s witnessed a rapid urban growth of the Karachi a huge built up (both industrial and commercial houses) leads to sudden boost in demand for electricity. Therefore, Karachi Electricity Supply Company has been granted license to generate and to distribute power in its licensed area. In 2000s, annual consumption of electricity in the residential sector has increased per customer, while annual consumption by each industrial customer has also reached at peak and widened the demand-supply gap. In 2006, the Asian Development Bank has estimated that 45 percent of Pakistan's population lacked access to electricity. Electricity crisis worsens in Pakistan in 2008 as shortage of Electricity has increased up to 4000MV. Pakistan's industrial consumers were facing an electric power deficit due to low water levels at hydroelectric dams. The task of accelerating the pace of power development picked up speed and by 1970, in another five years the generating capability rose from 636 MW to 1331 MW with installation of a number of thermal and hydel power units. In the year 1980 the system capacity touched 3000 MW which rapidly rose to over 7000 MW in 1990-91. Year 2011 started with electricity shortages and worst load shedding of all time and ending with the same situation. Summers were worst period for Pakistan people where in some areas load shedding of even 16 to 18 hours were witnessed but the winters were also worst of all with up 8 hours of load shedding. Prices of electricity were also kept increasing. Electricity shortages caused losses to industry, in turn causing many closures and loss of jobs for people of Pakistan.

During 2013-14, the diversion between energy demand and supply continued which severely affected in various sectors of the economy. The shortage further widened the trade balance due to high prices of energy in the international market. Due to the ongoing shortfall of electricity, there is persistent increase in load shedding in Pakistan for 8 to 10 hours in settled areas and 12 to 16 hours in villages (PEPCO, 2013-14 and Economic Survey of Pakistan, 2013-14). The existing shortage of energy not only increased import bills, but also affected macro economic variables like inflation, budget deficit, current account balance (BOP), foreign exchange reserves, exchange rate, employment level, GDP, and has also adversely affected the standard of living of residents of the country Asif (2011).

The total energy consumption in Pakistan is 63.1 MTOE[1] and supply of energy is 48.01 MTOE in 2009-10. During 2001-02 to 2009-10, the supply of coal, gas, electricity and petroleum products increased by 9.3, 6.3, 3.5 and 1.1 percent per annum respectively. Average total share of oil in total energy consumption is 27.9% in 2009-10. Due to oil price hike, the demand for oil decreased by 8.6% from 2004-05 to 2009-10, because the demand shifted from oil to other cheaper sources of energy. The electricity share in total energy mix during 2009-10 was 15.6% and its demand has increased up to 5.2% annually from 2001-02 to 2009-10. The share of gas in total energy consumption is 43.9% during 2009-10. Available natural gas reserve has been 26.62 trillion cubic feet. The transport and household showed increasing demand for gas by 14.3% and 0.75% respectively. Coal share in the energy mix is 11% during 2009-10. Pakistan has 185 billion tons coal reserves out of which only 175 billion tones are estimated in Thar (Economic Survey of Pakistan, 2010-11).

To stimulate economic growth, industrialization, agriculture productivity, growth in services and providing electricity to rural areas, it is important to seek additional sources of energy and further to utilize these resources efficiently. But unfortunately, in Pakistan the natural resources explorations combined with under utilization, mismanagement and ill-planning of energy are the key challenges. From the last two decades Pakistan is faced with severe energy crises. Increase in energy demand further manifold these crises. In future, Pakistan will confront 31% shortage in energy, which will severely affect the different sectors of national economy like agriculture, industry, transport, services and commercial sector. The economic growth rate in 2009-10 was severely affected by shortage in energy availability (SBP, 2006 and Economic Survey of Pakistan 2009-10).

Forecasting of energy demand and supply is very crucial for the future growth and development of a country. While correct energy demand and supply forecasting are made by the researchers, planners and government, it will help to handle energy crises effectively. Particularly for country like Pakistan, accurate forecasting is very essential because in Pakistan the gap between energy demand and supply is widening day by

[1] Million Ton Oil Equivalent

day.

Pakistan faces a lot of challenges ranging from poverty, low economic growth, political instability, terrorism to energy crisis. The most important among all these challenges is the electricity crisis as it roots cause of many other problems like poverty, unemployment, sluggish economic growth and low standard of living of the masses. Therefore it is important to investigate the determinants of electricity which will help us in the understandings of the output of electricity.

3. Methodology

For analysis of the determinants of electricity supply, the basic theory of supply is in support of theoretical background of the present study. Here supply of electricity means output offered for sale at given price. It is obvious that the suppliers offer more for sale at higher price and low at lower price and other determinants like cost of production, price of substitute, technology, weather condition and stock of capital etc have effect on energy supply. Due to unusualness in energy market in Pakistan the stated law of supply may not inevitably hold, because usually components of electricity supply by government and enjoy monopoly power.

3.1 Data and Data Sources

In this study, times series secondary annual data on different variables in favor of empirical analysis for the period ranging from 1970 to 2014 has been used. The data required for the study is obtained from various sources. The data for total electricity supply, total petroleum import and rain fall are taken from Economic Survey of Pakistan various issues. The numerical data of price per unit of electricity has taken from WAPDA. Electricity transmission and distribution loss data is obtained from IMF (2013- 14). The electricity supply variable is computed by subtracting total electricity transmission and distribution loss from total electricity generation and technology variable is taken as proxy by time trended. The data on final oil price as an index is constructed separately for oil. As for as the price is concerned; it defer from sector to sector and component to component. For instance, the oil has different components like motor spirit, high speed diesel, light speed diesel, kerosene, and furnace oil with their respective prices. Similarly, the prices vary across sectors and across consumers. Energy year books report all this prices data in quite details. To construct aggregate price indexes for oil we used the tool of weighted average index approach. The weights could be constructed by using the relative consumption share and the time base. Time weight means that if a price is effective for thirty days, for example, it will get twice as much weight as compared to price which is effective for fifteen days.

3.2.Modeling for Electricity Supply

To assess the determinants of electricity supply in Pakistan, the following model has estimated: The designs of the model of electricity supply for the study are consistent with the literature of Isola (2007), IEA (2002), Lledare (1995), Lwayemi (2008), Ubi (2012). It provides foundation for identification of the determinants of electricity supply of Pakistan.

$$\ln TES = \beta_{0+} \beta_1 LnRF + \beta_2 LnTEMP + \beta_3 LnETDL + \beta_4 SPE + \beta_5 FOP + \beta_6 TREND + \varepsilon t$$

Where

TES = Total Electricity Supply
RF = Rain Fall (mm)
TPM = Petroleum Import as a percentage of GDP
ETDL=Electricity Transmission and Distribution loss growth
FOP = Final Oil Price
SPE = Average Sale of Electricity
@ TREND = Technology

3.3 Variable's Description:

a) Supply of Electricity:

Total consumption of electricity in different sectors of the economy is taken as dependent variables. In the study total consumption of electricity is denoted by "TEC" and the supply of electricity is represented by "TES".

b) Prices of Energy Components:

Price and price of substitutes are important determinants of energy supply. Usually supply and price has positive association an increase in price occurs increase in supply of energy and vice versa. In Pakistan prices of energy set administratively, that ultimately help in enhancing revenue generation, it further invests in energy oriented technology sectors which will increase energy supply. Price of substitute goods has considerable effect on energy supply. Prices of electricity, petroleum, gas and coal are represented by "SPE", "FOP", "FGP" and "SPC" respectively

c）Energy Imports:

Imports of oil and coal have positive effect on energy supply. The production of electricity raises especially from thermal power stations with import of petroleum, moreover the consumption of oil/ petroleum increases in all sectors of the economy. Due to import of coal the overall supply of coal rises and consumption of coal increases by bricks and cements industries. The import of petroleum and coal are denoted by "TPM" and "TCM".

d)Electricity Transmission and Distribution Loss:

Electricity supply sector of Pakistan is highly attributed to power and revenue loss which comprise of technical and non-technical loss. Technical loss associated with transmission and distribution loss, which was 15184 GWH in 2012. It indicates lack of government funds allocation to electricity distribution and transmission networks. Power loss has negative effect on electricity supply. The electricity transmission and distribution loss is represented by "ETDL" in this study.

e)Weather Factors:

Energy demand and supply depend on seasonal variation. In winter for heating purposes the demand for energy is high, while in summer the demand of energy (electricity and oil) is also high. With rainfall the supply of electricity from hydro power stations will increase. Moreover in cold temperature the supply of electricity from hydro sector is low due to less reserve of water and gas supply also remains low. In hot weather the supply of energy especially electricity and coal are low. Temperature is denoted by "TEMP" and rainfall represent by "RF".

f)Technology:

It is one of the essential factors of energy supply and demand. Advancement in technology in favors of energy sectors will boost up energy supply. Introduction of suitable technology in energy sectors will insure specialization and division of labor and ultimate enhance energy supply at lower cost, it may raise energy consumption. Technology is denoted by @trend.

3.4 Quantitative Analysis

To assess the desired objective this study employed different techniques to investigate the problem of stationarity, estimates of the parameters and estimates of the forecast. Following techniques are used in this study.

3.4.1 Stationarity Test

The study has used Augmented Dickey Fuller test for stationarity of data. The results of ADF test are given in table 1. According to the t-statistics value of ADF test for all the following variables (LTES LRF LTPM LETDL LSPE LFOP LGFCF) are statistically significant at first difference. Thus the variables turn out to be stationary at first difference or order 1(1).

Table 1: ADF Test for Unit Root

Variables	Level		First difference		Conclusion
	Statistic value	Critical value at 5%	Statistic value	Critical value at 5%	
LTES	-2.448330	-2.943427	-3.210393*	-2.945842	1(1)
LRF	-2.170968	-2.954021	-3.755754*	-2.957110	1(1)
LTPM	0.439443	-3.943427	-5.002766*	-2.945842	1(1)
LETDL	-1.941196	-2.941145	-6.409272*	-2.943427	1(1)
LSPE	-1.936823	-2.943427	-3.408085*	-2.945842	1(1)
LFOP	0.419443	-2.943427	-5.002766*	-2.945842	1(1)
LGFCF	-2.791136	-2.957110	-4.011347*	-2.960411	1(1)

* Denotes rejection of null hypothesis at 5% level of significance

3.4.2 Co-integration Test for Total Electricity Supply

The results of Johansen co-integration test are given in table 2. Trace statistics and Maximum Eigen values are used to show the number of co-integration vectors. The null hypothesis of no co-integration ($R = 0$) against the alternative of co-integration ($R \leq 1$). The value trace statistics is 141.1862, which is greater than the value of critical value of 95.75366 and the maximum Eigen value is 68.56691, which is greater than the critical value of 40.07757 at 5 percent level of significance. Hence null hypothesis is rejected and co-integration is accepted as alternative hypothesis. The trace statistics confirms two co integrating vectors and the maximum Eigen value also confirms one co integrating vectors at 5 percent significance level.

Thus the results confirm the existence of long run relationship between total electricity supply, rain fall, petroleum import, electricity transmission and distribution loss, sale price of electricity, price of oil and technology.

Table 2: Johansen Co-integration Test for Total Electricity Supply's Results

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5 % Critical Value	Max- Eigen Statistics	5 % Critical Value
R = 0	R ≥ 1	141.1862*	95.75366	68.56691*	40.07757
R ≤ 1	R ≥ 2	72.61927*	69.81889	30.98785	33.87687
R ≤ 2	R ≥ 3	41.63142	47.85613	21.36195	27.58434
R ≤ 3	R ≥ 4	20.26947	29.79707	9.978867	21.13162
R ≤ 4	R ≥ 5	10.29061	15.49471	8.952858	14.26460
R ≤ 5	R ≥ 6	1.337750	3.841466	1.337750	3.841466

5.4 Multiple regression Models estimation

The variables of the study are stationary and co integrated after applying the ADF and Johansen co-integration tests. Therefore the results obtained from OLS are not spurious. The following multiple regression models are used to estimate the determinants of components of energy consumption.

5.4.1 Estimation of Determinants of Total Electricity Supply

The results of multiple regressions have been given in table 3. The results show that Rain fall (RF) directly affects electricity supply. The implication of this result is 1 %, increase in RF will bring 0.059337 % increase in electricity supply. The sign of RF confirms with theoretical expectation but statistically insignificant at 5 percent level. This means that the whole electricity is not generated from water reserve, only 33.6 percent electricity was generated from hydel and the rest of electricity was generated from other sources (Economic Survey of Pakistan 2011-12). The given result is unison with Isola (2007) and Ubi (2012).

The value of coefficient of petroleum import (TPM) is 0.176960, indicates positive relationship between total petroleum import and electricity supply. This means that 1 percent increase in TPM would lead to 0.100085 percent increase in electricity supply. This variable is in line with economic theory and also statistically significant at 5 percent level. Also, value of electricity transmission and distribution loss (ETDL) is negative and according to theoretical expectation. In other words, 1 percent increase in ETDL will decrease electricity supply by 0.068233 percent. The coefficient of the ETDL is statistically significant at 10 percent level of significance. The result indicates that electricity transmission and distribution loss is dominant determinant of electricity, which suggests the injection of funds in favor of technology related to transmission and distribution of electricity. The sign of the coefficient is in line with Ubi (2012).

The inelastic price elasticity is 0.083617, showing direct relationship between electricity supply (TES) and price of electricity (P). This implies that if price of electricity increase by 1 %, electricity supply will increase by 0.083617 %. The coefficient of price of electricity is statistically insignificant at 5 % level of significance due to the reasons that electricity is supplied under government owned companies and profit making is not primary objective. Along with this Pakistan provided subsidies on electricity consumption about Rs 346.096 bn in 2010, it may perhaps under price. Therefore price is not dominant factor of electricity supply in Pakistan. The result has the same opinion with Ubi (2012).

The cross inelastic price elasticity is -0.166118 shows inverse relationship between electricity supply (TES) and price of substitute (final oil prices, FOP). This implies that if price of substitutes increase by 1 %, electricity supply will increase by 0.166118 %. The coefficient of price of electricity is statistically significant at 8 % level of significance rather on 5 %. Again due to the same reason discussed above electricity generation in Pakistan is not dependent as a whole on petroleum, but contribution of electricity generation from petroleum was also 35.1 % in 2010 and the rest of electricity was generated from other sources (Economic Survey of Pakistan 2011-12).

The result shows that technology (@TREND use as proxy of technology) is statistically significant at 5 % level of significance and has positive relationship with electricity supply. A one percent increases in technology will least impact in the form of increase in electricity supply by 0.070843 %. Technology is one of the vital determinants of electricity supply and impels policy attention. The result is corresponding with Isola (2007) and Lwayemi (2008).

The adjusted R^2 is 0.964155 which shows that 96 % of variation in total electricity supply has been explained due to changes in included explanatory variables, hence the fit is good. The value of F- statistic indicates that overall model is statistically significant at 5 % level of significance. The Durbin- Watson statistic value is 1.850678, which indicates that autocorrelation problem is not too much severe.

Table 3: Results of Determinants of Total Electricity Supply

Dependent variable LTES			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	7.525798	8.101936	0.0000
LRF	0.059337	0.894760	0.3776
LTPM	0.176960	2.341769	0.0256
LETDL	-0.068233	-0.486016	0.1003
LSPE	0.083617	0.427341	0.6720
LFOP	-0.166118	-1.766113	0.0869
@TREND	0.070843	4.548094	0.0001
R2= 0.976657 AdjR2= 0.964155		F-Stat = 394.3667 Prob(F-stat)= 0.000000	
Durbin-Watson = 1.850678			

5.5.1. ECM Results for Total Electricity Supply

The results of ECM are given in table 4. It shows that in short run lag value of TES, RF and lag value of RF and TPM have positive but statistically insignificant effects on total electricity supply but TPM has statistically significant at 8%. While other variables of SPE and lag value of SPE and FOP have negative but statistically insignificant effects on TES except ETDL has significant at 5% level of significant. The table illustrates that the variables have no strong relation in short run analysis; further the results indicate the effects of lag values of all variables on TES were insignificant. The coefficient of error correction term is negative and has statistically significant at 5% level, which confirms long run equilibrium among variables of interest is stable. In case of shock there will be a convergence to long run equilibrium.

Table 4: ECM results for Total Electricity Supply

Dependent variable D(LTES)			
Variable	**Coefficient**	**T-statistic**	**Prob.**
Constant	0.088725	3.577229	0.0013
D(LTES-1)	0.129595	0.731458	0.4708
D(LRF)	0.033153	1.007939	0.3224
D(LRF-1)	0.020534	0.582525	0.5650
D(LTPM)	0.130796	1.830004	0.0783
D(LETDL)	-0.181612	-2.298605	0.0295
D(LSPE)	-0.108223	-0.915483	0.3680
D(LSPE-1)	-0.176789	-1.375551	0.1803
D(LFOP)	-0.014734	-0.216989	0.8298
ECT05(-1)	-0.192146	-1.991321	0.0467
R^2= 0.379894 F-Stat = 2.837882		AdjR^2= 0.173192 Prob(F-stat) = 0.0494	
Durbin-Watson = 1.87981			

5.6.1 Forecasts of Total Electricity Supply

The forecast results of total electricity supply for the year up to 2025 are determined below in table 5. By using ARIMA model it indicates on average the forecasted values of total electricity supply for the year 2015 to 2020 and 2020 to 2025 will be 95429.4 and 106505.6 Gwh respectively and as whole average total electricity supply in Pakistan from 2015 to 2025 will be 96461.66 Gwh. The result shows that in future the increase will occur in total electricity supply and turn out to be 112499 Gwh in 2025. Forecast conducted NTDC (2008) are over estimated then estimated forecast. The NTDC forecast for the years 2010, 2015, 2020 and 2025 are 83463, 181018, 276937 and 409874 Gwh respectively. Also actual electricity supply in 2010 is 80424 Gwh (Economic Survey of Pakistan 2010-11), it is quite low then forecast by NTDC. The study forecasts are within acceptable bound at 95 % confidence interval and estimated forecast of electricity supply in 2011 is almost equal to actual value that is 77099 Gwh (Economic Survey of Pakistan 2011-12). Hence the study forecast is better than official forecast.

Table 5: Forecasting of Total Electricity Supply from 2011 to 2025

Projected Years	Forecasted electricity supply (Gwh)	Lower 95% confidence interval	Upper 95% confidence interval
2015	94278	84264	104292
2016	89147	77700	100593
2017	91239	79142	103336
2018	100836	88268	113404
2019	100752	87118	114387
2020	95173	80533	109813
2021	101376	86365	116387
2022	110379	94897	125861
2023	106056	89515	122597
2024	102218	84999	119437
2025	112499	95040	129958

Conclusion and policy suggestions

It is found that RF, TPM, SPE, FOP and Technology have positive while ETDL has negative effect on total electricity supply. All variables are consistent with economic theory. Moreover TPM, ETDL, FOP and Technology are strong determinants of electricity supply in Pakistan.

This study finds from empirical findings that electricity transmission and distribution loss has negatively effect on electricity supply, because electricity transmission and distribution system of Pakistan is out dated and aging equipments. In order to get rid from this problem government should inject funds in favor of technology in transmission and distribution system of electricity to ease power loss and raise electricity supply to meet increasing demand of electricity.

To bridge the increasing gap between energy demand and supply as we find from forecasting of energy consumption and supply. It is important to sort out alternative techniques and resources. It is also essential to focus on gas and coal base electricity in collaboration with private sector and public sector. Atomic energy sector shall also be exploited more extensively instead of depending on costly fuel.

Energy especially electricity shortage has augment due to electricity transmission and distribution loss, aging and poor technology and other sectors of energy as coal, solar, nuclear and wind are not utilize properly. Along with Electricity theft is one of key concerned issue in Pakistan increasing day by day and exacerbates electricity crises. In order to minimize electricity theft introduction of technology and proper management of transmission and distribution system of electricity is of utmost importance. Moreover, the private sector should be encouraged in distribution of electricity to start competition and reduce electricity theft and losses.

Finding of the study suggests that energy import escalate energy supply. To bridge gap between energy demands and supply an agreement should be made with different countries especially with neighboring countries to import electricity and gas. It will help in reducing energy crises and create competition in energy market, and achieve ultimate goal of reducing price of energy in a country.

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