PAKISTAN'S ENERGY CHOICE: WHAT DETERMINES THE ECONOMIC GROWTH?

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ABSTRACT

Purpose: Over a decade Pakistan has been facing severe electricity crisis. The electricity crises and load shedding of more than 10 hours in a day hampers all the economic activities both in rural & urban areas. The purpose of the study was to find out the association between Electricity generation resources (Energy Mix) and Economic growth.

Methodology: The study is quantitative in nature. Secondary data of energy generation of 46 years, from 1071 to 2016 has been taken from Economic survey of Pakistan for the statistical tests. ADF test was conducted to check the Stationery of the data. Later cointegaration test was conducted to check the association among variables.

Findings: The key findings of the study were that in short term energy resources from Hydel & Thermal determine the Economic Growth. Whereas, in long run only energy generation from thermal sources has positive impact on Economic Growth.

Implications: For a developing country like Pakistan, attainment of ideal energy mix is the key for energy crises. The current study is very much helpful for the policy makers for the decision of ideal energy mix for Electricity generation which is not only the economical one but also sustainable for the country.

Keywords: *Electricity Generation, Economic Growth*

Jel Classification: Q43, C52.

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1. INTRODUCTION

Energy is the sustenance of all developed economies. Adequate supply of energy is the key for all productive activities in today's era. Whether it is transport or communication, agriculture or industry, education or services, water supply or sanitation, entertainment or health care, it is unthinkable to carry on any of the mentioned activities without the accessibility of proper supply of energy in one form or the other. In today's world, Electricity is the most commonly used form of energy. Its generation is reliant on different forms of energy. By the year 2050 global demand of energy is expected to be doubled by 2050 as compare to 2000 levels. Thus in today's world attainment of Economic Growth depends on accessibility to dependable, affordable and continuous supply of energy.

1.1Background

The continual and adequate supply of electric power is one of the most decisive factors for Economic Growth of the economy and especially for under developed countries. However, in Pakistan the electricity sector has been historically characterized by huge shortage and outages.

Over a decade, Pakistan has been facing major socio-economic crunch because of the inaccessibility of electricity on a persistent and affordable basis. The electricity crisis is basically caused by increase in demand, supply constraints, transmission and distribution losses and ineptitude in generation etc. This acute shortage of electricity is not only disturbing the routine life of people but also hampering overall economic development of the country.

1.2 History of Energy Crisis

In last 27 years, the country has gone through both phases of having surplus energy and a huge deficit or energy crisis. The country enjoyed electricity surplus status from the year 1990 to 2005. The current energy crisis started from 2006. Since then Pakistan's population has rapidly risen. Due to industrial boom and more electricity need for common people because of urbanization, demand for energy increased drastically and situation has continued to be worsened till the present day. The gap between demand and supply has grown in such a way that in the year 2011 the deficit was recorded around 5000 MW. In May 2011 it was around 7000 MW and even in June 2012 electricity shortfalls reached around 40% of National Demand i.e upto a peak of 8,500 megawatts (MW). Currently 12 hours load shedding is very much routine practices in urban areas and in rural areas even its upto 18 hours a day.

1.3 Electricity Generation in Pakistan

Pakistan is blessed with such a demographic position that has ample energy resources. It has ideal river system with abundance opportunity for electricity generation, rich in natural gas and also has one of the biggest coal reserves at Thar, Sind. From three most important sources of energy, hydro projects are in political doll drum and bigger projects are only upto feasibility status and their costs of projects are increasing day by day. Power generation through thermal sources also resultant in the depletion of local reserves, which could be depleted in next 15 to 20 years as the local consumption in transportation industry is also touches its peak. Moreover, Thar has one of the biggest coal reserves but still not explored for power generation. Pakistan power generation dependency is too much on oil imports which

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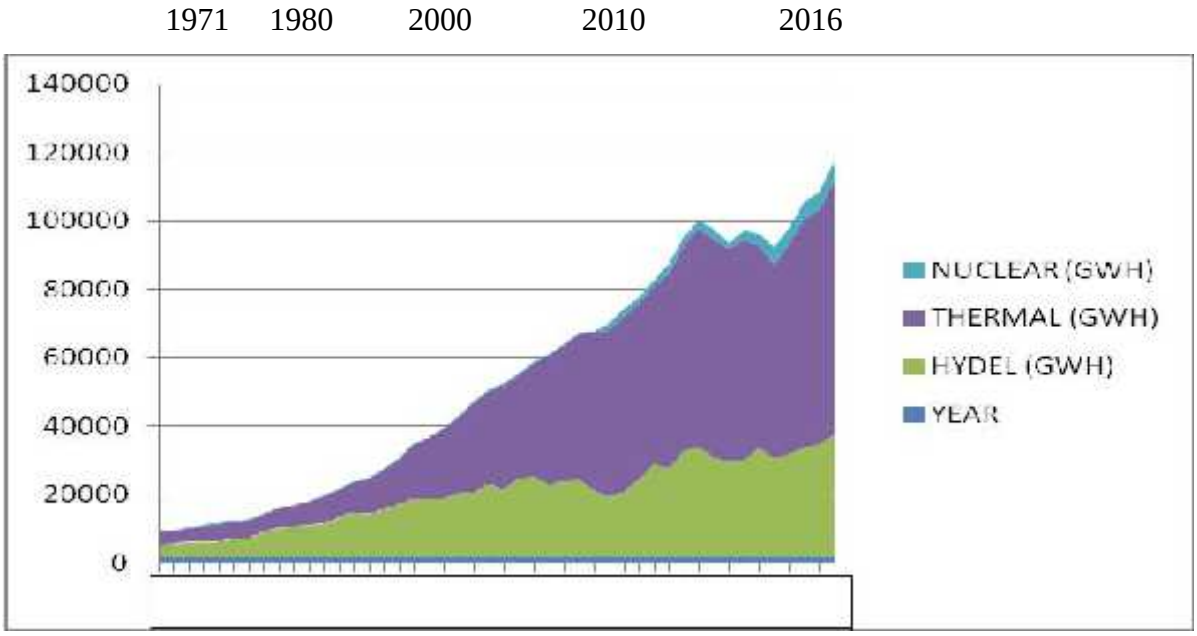
also disturbing the balance of payment. For Pakistan energy mix is the ideal solution for its power generation.



Above chart showed the energy mix of electricity generation of Pakistan for last 46 years from 1971 till 2016. The most important concern while growing the sources of power generation is to consider the most suitable resource mix which resultant in higher efficiency and feasible for economy. Most of the electricity generated in the country is from Hydel, Thermal & Nuclear resources. In early 70s most of the generation was from Hydel resources. Whereas, in next 25 years sharing in power generation was almost 50% in between Hydel & Thermal sources. Currently, thermal power generation dominated the generation from Hydel & Nuclear resources.

1.4 Electricity Generation & Economic Growth

There have been many investigations over recent decades to inspect the nexus between power utilization and Economic development either for a solitary nation or for a gathering of nations. Despite the fact that the outcome on the course of causality isn't decisive, most investigations uncover that there exists a solid connection between economic growth and electricity consumption (Ferguson, et al. 2000). Few of the studies resultant in a bi-directional causality (Erol & Yu, 1998; Masih & Masih, 1996; Soytas & Sari, 2003; Asafu-Adjaye, 2000; Glasure, 2002; Jumbe, 2004; Mozumder & Marathe, 2007); Oh & Lee, 2004; lot of studies showed one directional causality (Cheng & Lai, 1997; Abosedra & Baghestani, 1989; Cheng, 1999; Aqeel & Butt, 2001; Yang, 2000; Morimoto & Hope, 2004; Cheng & Wong, 2001) and a small number of studies no causality between economic growth and electricity generation (Yu & Jin,1992; Akarca & Long, 1980; Cheng, 1995; Joyeux & Ripple, 2007; Glasure & Lee, 1997).

However, hardly very few of the studies test the relationship between electricity generation and EG (Yoo & Kim, 2006; Rashid & Alam, 2010) for Indonesia and Bangladesh. Not a single studied found which showed the relationship between energy mix (individual electricity generation resources) and economic growth. This study is the extension of Yoo & Kim, 2006; Rashid & Alam, 2010 studies to investigate the nexus between individual

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electricity generation resources and economic growth for Pakistan. Selecting the variable of electricity generation instead of electricity consumption as taken in most of the studies because line losses in Pakistan is around more than 30% which is very high as compared to global ratio of around early two digits.

Pakistan, over a decade has been facing not only the energy generation crises but also with the decision dilemma about the ideal energy mix for the Electricity generation. Although lot of studies have already been made regarding energy consumption and Economic Growth but no association has been developed among energy mix with EG. The purpose of this study is to investigate a new dimension which has not been studied earlier, to study the causality between Energy mix (individual electricity generation resources) and Economic Growth of Pakistan, which would further open the door for policy makers to think about ideal energy mix applied, which is efficient and sustainable for the developing countries, especially for Pakistan and generally for other South Asian developing countries.

2. LITERATURE REVIEW

Examination of the association between power generation and EG constitutes a growing concern in past studies. In most of the studies factors of energy consumption & EG were analyzed. Literature of numbers of studies confirmed the strong association between energy consumption & EG. In some studies it is uni directional and some it is bi directional.

Altınay and Karagöl (2005) conducted study in Turkey for the period 1950 to 1057 and found unidirectional causality from electricity consumption to EG. Yoo and Kwak (2009), in their investigation about Brazil, Argentina, Chile, Ecuador, Colombia, Venezuela and Peru, concluded the existence of a single directional causality from electricity consumption to EG. Soytaş and Sarı (2007) studied the relationship between industrial production and energy in Turkey. They found unidirectional causality between electricity consumption for production. Sadorsky (2009), using panel data of 18 countries from the period 1994 to 2003 and studied association of renewable energy consumption with national income. It was concluded that 1% increase in real income, increases 3.5% of energy consumption.

Apergis and Payne (2009), in the study for 20 OECD countries using panel data for the period of 1985-2005, stated the presence of unidirectional long term association among GDP, real fixed capital investment, RE consumption and labor force. They also concluded bidirectional causality between renewable energy consumption and EG for both short term and long term.

The association of electricity generation with EG has hardly ever carried on previously. The association of electricity generation and EG is well recognized when effective policies of electricity generation implemented (Yoo and Kim, 2006).

Rashid & Alam (2010) applied test of Granger-causality on the nexus of EG and electricity generation of Bangladesh and taken annual data from 1973 till 2006. They concluded that only unidirectional causal association exists between electricity generation and EG.

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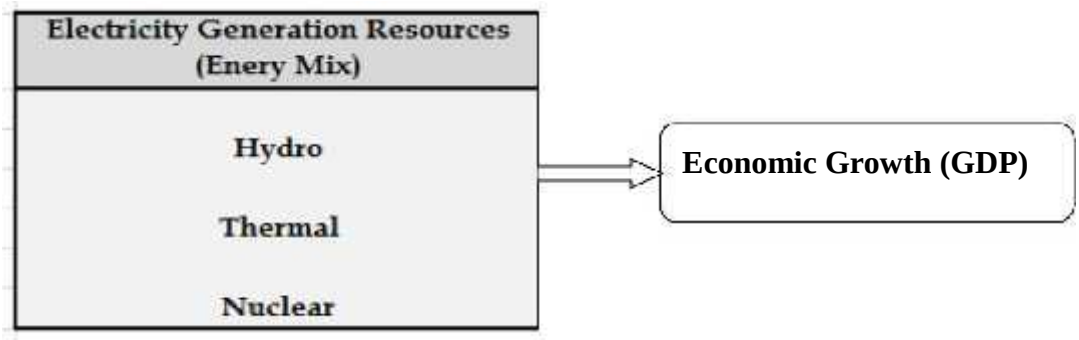
3. METHODOLOGY & MODEL

The current study is quantitative in nature. Following Yoo and Kim (2006) only two variables are taken, First, Electricity generation alongwith Hydel, Thermal & Nuclear sources as its sub variables and secondly, Economic growth as dependent one. Time series data from 1971 to 2016 are taken from Economic Survey of Pakistan. Electricity generation data are in MW and GDP in Millions.



3.1 Stationery test

When the study is based on secondary data further tests requires the time series data to be stationery so that the mean results and variance of applied variables do not differ analytically over time, as using of non-stationary data for further tests resultant in unauthentic results. The Augmented Dickey-Fuller (1979) (ADF) test has been applied for performing stationary of data.

3.2 Johansen Co integration Test

Two important approaches applied to check the existence of cointegration relationships are Johansen procedures and the Engle-Granger. In the current study Johansen's procedure is applied for cointegration between the variables of energy mix and EG.

3.3 VECM

When to compare VEM with VAR, it is a restricted form of unrestricted VAR (vector autoregressive) and restriction is basically the occurrence of the long run association among the series. All the series data are produced in the system of (ECM) error correction model.

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4. RESULTS & ANALYSIS

4.1 Stationary Test for Time series Data

	LEVEL		First Difference	
VARIABLES	**T-statistics**	**Critical value**	**T-statistics at 5%**	**Critical value at 5%**
GDP	-0.598	-3.610	-7.420	-4.615
Hydro	-0.380	-2.928	-7.108	-2.929
Nuclear	-1.140	-2.929	-8.432	-2.929
Thermal	-1.257	-2.928	-4.861	-2.929

The Augmented Dickey-Fuller (ADF) test is applied to check whether variables of electricity generation and GDP suffered unit root problem. Above table shows the results of the ADF tests. The table clearly indicates that all the variables are non stationary at level form because t- statistics of all the variables are less than the critical values at 5% level of significance. On the other hand at first difference all the variables become stationary because t- statistics are greater than the critical values. So in this condition when all the variables are I (1) it is suitable to apply Johansen Cointegration test and check the cointegration among the variables.

4.2 Johansen Co integration Test Result

ADF test proved that both the variables of the current study are non-stationary. Co integration test needed to be applied as a preceding step so to find out whether the two series are co integrated or not.

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.881682	154.9455	47.85613	0.0000
At most 1 *	0.800593	80.24234	29.79707	0.0000
At most 2 *	0.464292	23.80810	15.49471	0.0022
At most 3	0.054523	1.962304	3.841466	0.1613

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.881682	74.70317	27.58434	0.0000
At most 1 *	0.800593	56.43424	21.13162	0.0000
At most 2 *	0.464292	21.84579	14.26460	0.0026
At most 3	0.054523	1.962304	3.841466	0.1613

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Max-eigen value test indicates 3 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The above table shows that there are three cointegrating relationship among the variables according to both trace test and maximum Eigen value test.

4.3 Long run Equation

1 Cointegrating Equation(s): Log likelihood -1313.673

Normalized cointegrating coefficients (standard error in parentheses)

GDP	HYD	NUC	THER
1.000000	651.8691	2864.408	-110.8851
	(74.3954)	(520.870)	(38.3679)

Results analysis formulated the following long run equation:

GDP= -651.89*HYD – 2864.40*NUC + 110.88THER

The above equation is showing that Hydro and Nuclear energy production is negatively associated with GDP and only thermal is positively associated with GDP in the long run.

4.4 Short run (VECM)

Error Correction:	D(GDP)	D(HYD)	D(NUC)	D(THER)
CointEq1	0.049220	0.000179	-0.000132	0.000286
	(0.02323)	(9.6E-05)	(2.9E-05)	(0.00012)
	[2.11843]	[1.87838]	[-4.53835]	[2.35233]

The above table shows the results of Vector error correction model (VECM) which is useful for finding the short run dynamics among the variables. T values of all the variables are highly significant which means that our results are reliable. The signs of the coefficients show the divergence and convergence towards equilibrium, negative sign means convergence and positive signs mean divergence. So Nuclear energy production shows the negative sign which means disequilibrium is removed by about 0.073%. While Hydro, GDP and Thermal show the positive sign which means divergence and disequilibrium is increased by the value of their coefficients. By using these results the below short run equation is formed.

Short run Normalized Equation:

DLGD = 0.000179*DHYD – 0.000132*DNUC + 0.000286*DTHER

The above equation showing that Hydro and thermal is positively associated with the GDP and Nuclear energy production is negatively associated.

5. CONCLUSION

The objective of the study was to observe the causal relationship between electricity generation (Energy Mix) and Economic Growth (GDP) for Pakistan. Before causality testing,

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the ADF test employed to check stationary of the data and Johansen test for cointegration. The key findings of the current study is that in short run both Hydyl and Thermal sources of Energy determines the economic growth and in long term only the Thermal source of energy showed the relationship with Economic Growth. In both the cases energy generation from Nuclear sources don't have impact on EG.

The results showed that for short run the policy makers should focused on run river system and should consider the small Hydel projects instead of planning the bigger one as in other parts of the world concept of small dams are more feasible and economical.

The policy makers should also be focused on exploring the own resources of oil and gas reserves, as in Pakistan there are still unexplored areas for such reserves.

The long run results indicated that its easy to install power generation projects based on oil & thermal at the location where the transmission cost is minimum. As thermal is the key determination of Economic Growth the policy makers think about the proper utilization of gas reserves for more on power generation and less on transport sector. As the gas reserves are also depleting, simultaneously efforts towards exploration needed more focused efforts.

In the study the power generation from Renewable resources and also from coal not thoroughly covered. While finding the ideal Energy mix which is basically the key solution for energy crisis both the resources should also be considered and focused. In future the current study tends to support to the initiative of increasing power generation capacity to make sure the sustainable Economic Growth.

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