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IMPACT OF COAL ON ELECTRICITY GENERATION AND ECONOMIC GROWTH OF PAKISTAN

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ABSTRACT

Many countries of the developing world are facing the electricity shortage. Pakistan is also a developing country and it is facing the acute shortage of electricity. All most, all sectors of the economy are effecting due to this electricity shortage and economic progress is getting slower. The purpose of this study was to check the impact of coal on electricity generation and economic growth of Pakistan. The period of study was from 1981 to 2011. Augmented Dicky Fuller test was used to check the stationarity of the variable. The long run and significant impact of coal, gas, hydel, oil and nuclear on electricity generation was shown by using Johansen Co-integration test. All variables have positive relationship. The long run and significant impact of electricity generation on GDP was shown by using ARDL approach. It was concluded that coal has significant and positive impact on electricity generation with other sources of electricity generation and by generating the electricity from coal, the economy of Pakistan can grow, as it is cheap and efficient producer of electricity.

Keywords: Electricity Generation, Coal, Oil, Gas, Hydel, Nuclear

1. INTRODUCTION:

In the modern era, energy is considered to be very important part of the economic development of any country. Electricity is an important part of the energy, which plays an important role almost in every part of human life. Electricity also plays a role in the development of the economy of a country because with it much business runs like industries, machineries, offices, households, etc. So no one can deny the importance of the electricity in modern era.

Developing countries of the modern world are facing the energy crisis. Due to these crises, their economies are affecting a lot. Pakistan is also a developing country and facing energy crisis. Pakistan is facing the energy crisis since 1947. In 1947, the Pakistan's electricity generation capacity was 60 Mega Watt (MW) and demand was same. But with the passage of time, demand was increased as the population of Pakistan has grown. During 1960s to 1980s, Pakistan has constructed different dams like Tarbela, Mangla, Khanpur, etc and other plants for generating the electricity. By building new dams and adopting other methods for electricity generation in that era, electricity crisis were went down. In 1970's, Pakistan has also started generating the electricity from nuclear technology. Pakistan was successfully solving the electricity issues and generating it according to its requirement. But with the passage of time, as the population of Pakistan and the economy has grown, the requirement of electricity was improved.

After 1981, Pakistan has started facing electricity shortage again because of increasing demand and not increase in its generation. But in 2000's the problem of electricity shortage went worsen. Now Pakistan (2011 – 2013) is facing extreme electricity crisis not only in its rural areas but also in urban areas. Rural areas are facing load shedding of 14-16 hours per day and cities are facing this problem from 8-12 hours per day. Due to this crisis, the industries in major cities like Karachi, Faisalabad and Sialkot etc are also affecting and shutting down. People are closing their businesses and shifting it to other countries. The unemployment is increasing. The daily life routine of a common is also affected, etc. These energy crises are affecting almost every sector of Pakistan.

The main problem of these electricity crises is due to the mismanagement of resources of the country by different governments. The governments, who ruled over the country since 1947, have tried to generate electricity and formulate different strategies. But they did not give proper attention and importance for solving this problem. All governments were failed to fully implement the developed strategies practically for the production of electricity. They

were unable to develop new dams, power plants, adopting new ways of generating electricity, etc. The political parties from different parts of country have also opposed the different governments, who have tried to take any initiative in resolving this issue. The example of Kala Bagh dam is the big example of this kind done by different political sectors of Pakistan.

Presently, the total capacity installed for generating electricity in Pakistan is 22,477 Mega Watt (MW). Pakistan is not utilizing the whole capacity and it is using only 16,000 to 18,000 MW. Requirement of electricity in the country is almost 20,000MW. Pakistan is facing the shortage of 6,000 – 7,000 MW in all seasons. Mainly Pakistan generates electricity from oil, gas & hydro and little with nuclear and coal. Pakistan has also started producing electricity with renewable energy resources like solar energy, wind energy etc. But these renewable energy resources are producing very small part of the electricity. Pakistan uses oil and gas mostly in generating electricity and these both are expensive.

According to Pakistan Energy Year Book 2011, both oil and gas generates 35.2% and 29% of total electricity in Pakistan respectively. Hydel is third big source of electricity production in country and according to Pakistan Energy Year Book 2011; hydel produces 29.9% of the total electricity in the country. Nuclear is generating 5.8% of total electricity in the country. Pakistan is one of the 30 world countries, who are accessing the nuclear energy and utilizing it for different purposes, including electricity generation.

Coal is another source of energy and with it electricity can be produced. According to Pakistan Energy Year Book 2011; coal is generating 0.1% of the total electricity in the country. Coal is the cheapest source of generating electricity. Many developed countries are using the coal for the production of electricity. They are not depending on the oil or gas only, instead they are leaving these expensive sources and they are moving towards coal, nuclear and other renewable sources of electricity generation. Countries which are using coal for generating the electricity are like South Africa 88%, USA 52%, Poland 96%, China 78%, India 78%, Australia 77%, UK 37%, Germany 72% etc. By following these countries of the world, Pakistan can also increase the utilization of the coal for generation of electricity.

Pakistan has the large amount of reservoirs of coal. Pakistan has the 185 billion tons of coal reservoirs in all over the country. Pakistan is fourth country of the world, which have such large amount of coal reservoirs available. Thar Coal fields have the 175 billion tons reservoirs of coal alone. These coal reservoirs can be used for the generation of electricity, as it is found that Pakistan can generate 5000 MW electricity from Thar Coal fields for the next 800 years. This is a very cheap product and long term solution of the energy problems facing by the country.

Pakistan is facing enormous electricity shortage problems since long. If Pakistan utilizes its coal reservoirs for the generation of electricity then, it can reduce the dependence upon oil and gas for the electricity generation like many other countries of the world. Import of crude oil can be reduced and a large amount of money can be saved, also gas can be given to other parts of economy like households, industry etc, which are effecting with gas crisis. With generation of electricity from coal at Thar coal reservoirs, employment can be generated, industry can also be run, household shortage of electricity can be competed and economy of Pakistan can also be strengthened.

1.1. OBJECTIVES OF THE STUDY:

The objectives of the study are as follows:

a. To investigate the impact of coal on electricity generation.
b. To investigate that electricity generation from coal has the positive and long run impact on the economic growth of Pakistan.
c. To investigate that electricity has long run relationship with the economic growth of Pakistan.

2. LITERATURE REVIEW

Bodansky (1980) studied that the requirement of energy in the USA would increase in near future due to its growing economy requirements. The USA is generating its electricity mostly from crude oil, which it imports from other countries. It also uses the gas for this purpose. Now the USA should change its attitude towards electricity generation from oil to other renewable resources. Coal and nuclear are available and they are strong practical alternative for this purpose. As economy is growing, so the USA should start depending upon itself for the generation of electricity. The USA has the bulk resources of coal and nuclear power. Nuclear power is less cost effective than coal but coal is also an efficient factor for the electricity production. So, the USA would utilize all available resources for the self electricity generation.

Ghosh (1991) analyzed the challenges and opportunities facing by India in its energy sector and its demand management. In this study, it is stated that Coal is a primary source of energy. India has the better position in Coal reserves in comparison with oil. India has the large reservoirs of coal and it should enhance the use of coal for the energy generation. India's demand of electricity is increasing with its growing economy. Proper management for the coal utilization is required and in eight plan of Indian government, it is decided that India should use the coal for generation of electricity and make it friendly use. Also it should make the management of energy sector strong and able it to control all pros and cons of this matter.

Dunn (1991) studied the position of energy sector in Pakistan with its problems and prospects. Pakistan is a rapidly growing economy and the need of energy is growing. Industrial, Agriculture and household sectors are growing and that all are demanding more electricity. Pakistan is producing the electricity from oil, gas, coal, nuclear and other small sources but shortage of electricity exists there. Pakistan is full of resources, with which it can fulfill the demand of its electricity, but due to mismanagement, inefficiency and bad policies, these all are wasting. Coal is best option for producing the electricity and Pakistan has a large amount of coal available at Balochistan. If the policy makers of Pakistan make good policies and implement those all policies practically, then Pakistan can fight with the problem of electricity shortages. Pakistan has the capability to produce the electricity more than its demand.

Siddiqui (2004) studied that there exists a relationship between energy and economic growth of any country. The purpose of the study was to check the casual relationship between energy and economic growth in Pakistan from 1969 to 2002 and data sources are Pakistan Energy Year Book and Economic Survey of Pakistan. It is mentioned that the increasing prices of energy resources and also looking for the new energy resources has brought the problem of causality between energy and economic growth of the country. By using Autoregressive Distributed Lag model for results, trends of energy in Pakistan has been studied and said that Pakistan is facing energy problems due to which its economic growth is affecting. Petroleum, gas and electricity have the significant impact on the economic growth of any country but in Pakistan, they are effecting negatively. It was concluded that energy expansion was expected to lead to higher growth of economy. Pakistan should give attention to solve it energy crisis.

Altinay and Erdal (2005) studied that Turkey is a developed country and its requirement of electricity is increasing. The purpose of this study was to check the relationship between electricity supply and economic growth of Turkey. The researchers have studied the period from 1950 to 2000 and data on variables is collected from the State Institute of Statistics (2003). According to this study, it is found the strong relationship between electricity consumption and economic growth of Turkey. Researcher utilized the Granger Non-Causality test for this purpose and found that results are stationary. The results show that the continuous supply of electricity is useful for the economic growth and the electricity consumption in Turkey has an impact on its economic growth. So, Turkey should enhance the electricity production capacity and make its economy more strong. Electricity is very important for the economic growth in modern era.

Jafar *et al.* (2007) studied the impact of environment on alternative fuel mix in electricity generation in Malaysia from 1990 to 2003 and data source is Department of Statistics, Malaysia and Malaysian Energy Centre. Malaysia is fastest growing country and it is competing with the developed countries of the world. For its fastest growing economy and fastest growing industrial sector, continuous flow of electricity is required. It is generating electrify from oil, gas, coal and hydro power. It is analyzed that from last few years, the Malaysian electricity generation is shifting heavily on coal as it was 9.7% in 2000 but in 2003, it was 24.6%. The dependence on other resources is decreasing with the passage of time. By utilizing the Leontief's input-output framework, final results were proved that Malaysia should use fuel mix strategy for meeting the future demand of the electricity. The policy of conversion to other fuels can be applied for the purpose of electricity production.

Hou (2009) said that energy plays an important role in the development of the economy. As China is fast growing country and its energy demand is increasing day by day. This paper studied the relationship between energy consumption and economic growth of China from 1953 to 2006 and data on variables is collected from National Statistical Bureau and China Economic Information Network. By applying the techniques of Augmented Dicky Fuller, Hsiao's Granger causality and co-integration, it is proved that relationship between energy consumption and economic growth. Final conclusion is that there is a relationship between energy consumption and economic growth. China is a big consumer of energy and it is required on large scale. So China should use the as much as resources for generating the energy. As China increased its energy consumption with the passage of time, it economic growth will increase accordingly.

Akhtar *et al.* (2011) studied that coal has significant impact on the electricity generation from 1995 to 2007 and data is collected from Economic Survey of Pakistan. Pakistan is facing the energy crisis since long. These electricity crises are effecting the economic growth of Pakistan. It is said that demand of electricity is increasing in the

country but the supply is decreasing. Pakistan is generating electricity from different resources of energy. Pakistan has the large amount of coal reservoirs available like as Thar coal reservoirs. Pakistan can produce 5000 MW electricity from Thar coal reservoirs for next 800 years. It is said that coal is a cheap and efficient estimator than other energy resources. By using the OLS technique, it is proved that coal is an efficient estimator than other energy resources like hydro, oil, nuclear and gas. It is proved that coal has significant impact on electricity generation and economic growth of Pakistan. Final conclusion is that Pakistan should produce electricity by using Thar coal reservoirs for solving the issues of electricity crisis.

Javaid *et al.* (2011) studied the electrical energy crisis facing by Pakistan. According to this study, Pakistan is facing the electricity crisis since long but after 1980, the demand of electricity has increased and supply was not according to the requirement. Due to these electrical energy crises, households, industries and other parts of country are affecting a lot. The reasons for the problems of electricity are like mismanagement, failure of planning and future policy etc. Pakistan is generating electricity from hydel, thermal, nuclear and renewable energy resources. Pakistan is full of coal reservoirs and it had 185 billion tons reservoirs of coal in all over the country. Government of Pakistan is planning to utilize the coal for generating electricity from coal as soon as possible because it is cheap and effective element for the production of electricity instead of other resources. Pakistani government should take measures in this regard as soon as possible.

Jamil and Eatzaz (2011) studied the relationship of income and price elasticities of electricity demand from 1970 to 2005 and data is collected from Economic Survey of Pakistan. It is studied at aggregate level and sector wise. It is said that Pakistan is passing from the worse era of electricity crisis in its history. It is stated that the 80% part of total electricity production in Pakistan is used by agricultural, manufacturing, households sectors etc. By applying the Vector error correction and Co-integration techniques it is found that there is strong relationship between prices and income elasticities of electricity production. In Pakistan, when income rises then utilization of electricity will also rise. Policy makers can utilize the electricity price as a tool for the control over its usage and conversion. Pakistan is using crude oil for electricity production, which is costly. Pakistan should use other renewable resources for electricity production.

Zeshan (2012) developed a casual relationship between electricity production and economic growth of Pakistan from 1975 to 2010 and data is collected from Ministry of Water and Power Development, Pakistan. It is stated that electricity has a great effect on the economic development of any country. Pakistan is facing the electricity crisis since long. The power deficit will keep growing in future, if this problem does not solve. By using the co-integration and ARDL model, a relationship has been formed between the variables and it is found that investment of private sector in the production of electricity is very useful. Private sector investment has a long run relationship with electricity production and it has positive impact on the economy. It is stated that hydropower plant is best for the producing low cost electricity and it provides the clean electricity production. According to study, private sector is the best option for resolving the electricity problem of Pakistan.

3. METHODOLOGY AND DATA:

The purpose of this research study is to check the impact of coal on electricity generation and economy of Pakistan. Methodology section is important in this regard, because it shows the overall procedure of finding the results of the study. In this section, the details of econometric models used, independent and dependent variables, data and data sources are explained.

3.1. METHODOLOGICAL DESCRIPTION:

This portion is depending upon following parts:

3.1.1. VARIABLES OF THE STUDY:

The variables utilized in this study, are as follows:

3.1.1.1. DEPENDENT VARIABLE:

Electricity Generation

3.1.1.2. INDEPENDENT VARIABLES:

Coal, Gas, Hydel, Oil and Nuclear

3.1.2. DESCRIPTION OF VARIABLES:

3.1.2.1. ELECTRICITY GENERATION:

Electricity is very important factor and it plays an important role in the modern era. Electricity plays an important role in the economic growth of the country. Almost very work is done with the help of electricity. Pakistan is facing electricity shortage problem, due to which economy is suffering.

3.1.2.2. COAL:

Coal is important factor of electricity production and it is commonly utilized in different countries for electricity production. Pakistan has also number of coal reservoirs available and they can be utilized for the production of electricity and load shedding problem will be resolved.

3.1.2.3. GAS:

Gas is utilized for the production of electricity in Pakistan on a large scale after oil. Developed countries has left the gas for generation of electricity and using other cheap resources. Gas is one of expensive source of electricity generation in Pakistan. Pakistan has the reservoirs of gas in different stations of country, which are used for multiple purposes including electricity production.

3.1.2.4. HYDEL:

Hydel is another source of electricity production and many countries including Pakistan are utilizing it for this purpose. It is considered that the hydel is a cheap source of electricity production than other source. Pakistan is full of water resources and generating electricity from it. By improving this practice, Pakistan can improve it electricity generation capacity and boost its economy.

3.1.2.5. OIL:

Oil is another big source of electricity production and it is mostly used for the generation of electricity in Pakistan. Pakistan imports most of the crude oil for the generation of electricity. It is efficient but expensive thing for production of electricity.

3.1.2.6. NUCLEAR:

Nuclear is also utilized for the generation of electricity in many countries of the world. Nuclear is also considered as the cheap source of electricity generation as like hydel and coal. In Pakistan, nuclear is also used for the generation of electricity but at a minor level. If Pakistan increases the nuclear with other sources of electricity generation then the economy of Pakistan can be fully improved and dependence upon oil and gas can be reduced. The problems of electricity can be resolved positively.

3.2. MODEL SPECIFICATION (LOG LINEAR MODEL):

Log linear model is used for getting the reliable results. This model is widely used in the world for checking the relationship between the variables. The log linear models are appropriate, when there is no clear distinction between variables. Also they have two main objectives, first, they are flexible and second, they are interpretable easily. In this study, keeping in mind the study of Zeshan (2013), following model is formulated for this study. All variables data has been converted into log form to get the appropriate results. The model is:

Electricity Generation = f (Coal, Gas, Hydel, Oil, Nuclear

The log form of the model is:

$$LogY = \beta_o + \beta_1 Log\ Coal + \beta_2 Log\ Oil + \beta_3 Log\ Gas + \beta_4 Log\ Hydel + \beta_5 Log\ Nuclear + \varepsilon$$

Where Y = Electricty Generation

3.2.1. STATIONARITY OF DATA:

Unit root test is used for checking the stationarity of the data. Augmented Ducky Fuller (ADF) test is used for this purpose. This test is widely used in the world for checking of the stationarity of the time series variables.

3.2.2. CO-INTEGRATION MODEL:

Co-integration is the technique, which is widely used in the econometrics for checking the long run relationship between dependent and independent variables. This technique is applied in this study to check the long run relationship between the electricity generation as dependent variable and coal, gas, hydel, oil & nuclear as independent variables. (see for example, Zeshan (2013) and Jamil & Eatzaz (2011)).

3.2.3. AUTOREGRESSIVE DISTRIBUTIVE LAG (ARDL) MODEL:

To measure the long run relationship between gross domestic product (GDP) and electricity generation, ARDL method is used. (Follow; Zeshan (2013) used this method for checking the long run relationship.) It is a recent method developed in the economics for checking the long run relationship between the variables. ARDL was developed as a replace of Co-integration. Co-integration does not provide more effective results, according to some Economists.

3.3. DATA SOURCE:

The time series data is used in this study for showing the impact of coal on electricity generation and economy of Pakistan. The data is taken from the year 1981 to year 2011. A total of 31 years data has been utilized. As the data of all variables was in Giga Watt per Hour and it was converted in to the logarithmic form. It was converted into the log form for getting the effective results. So the interpretation of the results would be done in the percentage form.

The data is obtained from the Hand Book of Pakistan Economy, Economic Survey of Pakistan (various issues) and Pakistan Energy Yearbook (various issues). All sources are very useful for the data collection and widely used in the Pakistan for this purpose.

4. RESULTS AND DISCUSSION

The final results of the estimation are discussed in this part. Augmented Dicky Fuller Test was utilized for checking the stationarity of the variables. C0-integration technique is applied for checking the long run relationship between electricity generation, dependent variable and coal, oil, gas, hydel & nuclear. To check the long run relationship between the GDP and electricity, Autoregressive Distributive Lag model is used. The detailed discussion of the results is as follows:

4.1. CO-INTEGRATION MODEL:

4.1.1. AUGMENTED DICKY FULLER TEST (ADF):

Augmented Dicky Fuller test is used to check the stationarity level of the time series data. The hypotheses used for this purpose are:

H0: There is unit root in the time series data. (Non stationary)

H1: There is no unit root in the time series data. (Stationary)

By checking the required results, it was found that all the variables are non-stationary at level, I (0). In this regard, OLS technique cannot be applied. So, again the Stationarity of the data was checked on the 1st difference and it was found stationary at 1st difference, I (1). The table-1 given below is showing the required results:

Table 1 – Results of Augmented Dicky Fuller Test

Variables	ADF Test Value	Critical Value Level	Critical Values	Integrated
Electricity Generation	-6.7772	5% level 10% level	-2.9677 -2.6229	I(1)
Coal	-10.5300	5% level 10% level	-2.9677 -2.6229	I(1)
Gas	-3.8116	5% level 10% level	-2.9677 -2.6229	I(1)
Hydel	-6.3585	5% level 10% level	-2.9677 -2.6229	I(1)
Oil	-4.6002	5% level 10% level	-2.9677 -2.6229	I(1)
Nuclear	-6.2734	5% level 10% level	-2.9677 -2.6229	I(1)

The above table is showing that ADF test values are less than their corresponding critical values at all levels of 1%, 5% and 10%. These results are obtained at first difference with 1st lag. All variables are Stationary at the 1st lag of first difference in ADF test. So for further calculations, Co-integration technique was applied.

4.1.2. CO-INTEGRATION TEST:

Co-integration technique is a technique, which is used for the checking of the long run relationships between dependent and independent variables. For this purpose, Johanson Co-integration model is used here. The hypothesis of co-integration can be as:

H0: There is no Co-integration between the variables.

H1: There is Co-integration between the variables.

The calculated results are shown in the Table 2:

Table 2 – Results of Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Trace Statistics	0.05 Critical Value
None *	126.9625	95.75366
At most 1 *	81.69084	69.81889

The above table is showing the values of Trace statistics measured for the existence of co-integration between the variables. The above results are showing, in first two equations, the values of trace statistics are 126.9625 and 81.69084 are higher than the critical value 0.05, shown by star (*). So, it means that there is co-integration exists between the Dependent variable Electricity and independent variables Coal, Gas, Hydel, Oil and Nuclear. So there is long run relationship between the variables.

Table 3 – Results of Co-integration Rank Test (Maximum Eigen)

Hypothesized No. of CE(s)	Max-Eigen Statistic	0.05 Critical Value
None *	45.27170	40.07757
At most 1 *	36.20152	33.87687

The above table shows the values of Eigen statistics measured for the existence of co-integration between the variables. The results show that the values of Eigen statistics are larger than the critical value (0.05). It means that there exists co-integration between the dependent variable (electricity) and independent variables like Coal, Gas, Hydel, Oil and Nuclear. So there is long run relationship between the variables.

Table 4 – Results of Normalized Co-integration Estimation Technique

Variables	Coefficients	Standard Errors	t-values
Coal	-0.013191	0.00608	(2.1696)*
Gas	-0.451290	0.02456	(18.375)*
Hydel	-0.217102	0.04487	(4.8384)*
Oil	-0.008260	0.00726	(2.1472)*
Nuclear	-0.174671	0.01100	(15.8791)*

Note: (*) shows that t-value is significant at 0.05%. Significant values of t are greater than 1.

The co-integration equation is:

$$LogElect = \beta_o + \beta_1 LogCoal + \beta_2 LogGas + \beta_3 LogHydel + \beta_4 Log\ Oil + \beta_5 LogNuclear + \varepsilon i$$

From the above equation, independent variables Coal, Gas, Hydel, Oil and Nuclear are affecting the dependent variable Electricity. Coal, Gas, Hydel, Oil and Nuclear are important variables for the generation of Electricity in any economy. So there is a long run relationship between all these variables and they have long run impact with each other.

From the above Table 4, following results are concluded:

One percent increase in the coal will bring the 1.32 percent increase in the electricity generation. It means that when the use of coal will increase, it will bring the increase in the electricity generation and it will effect positively in long run on the economy of Pakistan. The t-value 2.1696 is significant and also showing the significant impact of the coal on electricity generation in long run.

One percent increase in the gas will bring the 0.451290 percent increase in the electricity generation. It means that when the use of gas will increase, it will bring the increase in the electricity generation and it will effect positively in long run on the economy of Pakistan. The t-value 18.375 is significant and also showing the significant impact of the gas on electricity generation in long run.

One percent increase in the hydel will bring the about 2 percent increase in the electricity generation. It means that when the use of hydel will increase, it will bring the increase in the electricity generation and it will effect positively in long run on the economy of Pakistan. The t-value 4.8384 is significant and also showing the significant impact of the hydel on electricity generation in long run.

One percent increase in the oil will bring the 0.8 percent increase in the electricity generation. It means that when the use of oil will increase, it will bring the increase in the electricity generation and it will effect positively in long run on the economy of Pakistan. The t-value 2.1472 is significant and also showing the significant impact of the oil on electricity generation in long run.

One percent increase in the nuclear will bring the 0.174671 percent increase in the electricity generation. It means that when the use of nuclear will increase, it will bring the increase in the electricity generation and it will effect positively in long run on the economy of Pakistan. The t-value 15.8791 is significant and also showing the significant impact of the nuclear on electricity generation in long run.

Energy resources have always the positive impact. Energy resources coal, gas, oil, hyder and nuclear have the positive impact on the generation of electricity and it always remain positive. When there will be increase in one percent of any energy resource utilization, it definitely bring some positive increase in the electricity generation. By increase in the electricity generation, the economy of the country will grow. So, it can be said that the energy resources, coal, gas, hydel, oil and nuclear have the strong impact on the economy of the country.

So from above all discussion, it can be said that the energy resources used for the generation of electricity in Pakistan are coal, gas, hydel, oil and nuclear has the positive and long run impact on it. So these sources can be used for the generation of electricity. Coal has also shown the positive and long run impact on the electricity generation, same as other resources. Pakistan can use its coal resources for the generation of electricity on large scale, as it has the large amount of coal reservoirs is available and they can be used for the long run generation of electricity.

4.2. VECTOR ERROR CORRECTION MODEL (VECM):

The long run impact of coal, gas, hydel, oil and nuclear on the generation of electricity has shown in the above part. These variables have also the short run impact on the electricity generation. This short run impact also effect the economy of Pakistan. VECM is used for the checking of the short run impact of the independent variables on the electricity generation. The results are in Table 5:

Table 5 – Results of Vector Error Correction Model

Variables	Coefficient	Standard Error	t-values
D(ELECT)	-0.711511	0.43050	-1.65275
D(COAL)	-5.169065	2.22266	-2.32563
D(GAS)	-1.486495	0.43667	-3.40415
D(HYDEL)	-0.661394	0.50760	-1.30298
D(OIL)	0.662621	1.04452	0.63438
D(NUCLEAR)	-0.320717	3.94189	-0.08136

The above table of VECM is showing the short run impact of coal, gas, hydel, oil and nuclear on the electricity generation. Coal, gas, hydel and nuclear are showing the negative impact on the electricity generation in the short run in Pakistan. Only oil is showing the positive impact on the electricity generation in short run. Logically it can be seen that in Pakistan, oil is mostly use for the generation of electricity than other sources. So it has a positive impact in short run, that is 66 percent.

The results have shown the coal, gas, hydel and nuclear has negative and oil has the positive impact on the electricity generation in short run period in Pakistan. The estimated coefficient value of electricity generation is 71 percent and it is showing the significant impact.

VECM results has shown the short run adjustment speed of electricity (-0.711511), coal (-5.169065), gas (-1.486495), hydel (-0.661394), oil (0.662621) and nuclear (-0.320717) towards the long run equilibrium position shown in the table 5. The estimated coefficient value of error correction is 71% of the disequilibrium in electricity will be corrected in short run period. The estimated coefficient of vector error correction of coal, gas, hydel and nuclear will be corrected in short run.

4.3. AUTOREGRESSIVE DISTRIBUTIVE LAG (ARDL) MODEL:

4.3.1. AUGMENTED DICKY FULLER TEST (ADF):

Augmented Dicky Fuller Test (ADF) test was used to check the stationarity level of the electricity generation and GDP of Pakistan. The results of the ADF test are given in Table 6:

Table 6 – Results of Augmented Dicky Fuller Test

Variables	ADF Test Value	Critical Value Level	Critical Values	Integrated
GDP	-3.988877	5% level 10% level	-3.568379 -3.218382	I(0)
Electricity Generation	-6.7772	5% level 10% level	-2.9677 -2.6229	I(1)

The above results shown that the Stationarity level of GDP is -3.988877, which is greater than critical value at 5 and 10 percent level. It was calculated at level I(0) and at trend & intercept level. So I(0) is the stationarity level of the GDP. But the value of Stationarity level of electricity generation is -6.7772, which is greater than critical value at 1%, 5% and 10% level. It was calculated at first difference and order is I(1). So here as our variables are showing the Stationarity at different points of ADF test, which are level and first difference. So at this stage, OLS and co-integration techniques cannot be applied. So for checking the long run relationship, ARDL test is used.

4.3.2. AUTOREGRESSIVE DISTRIBUTIVE LAG (ARDL) MODEL:

ARDL model is used to check the long run relationship between the variables. It is very useful method for checking the long run relationship between the variables in the modern world. The null hypothesis used in this study is:

H0: There is no long run relationship between GDP and Electricity.

H1: There is long run relationship between GDP and Electricity.

The ARDL test is applied and the calculated results of the gross domestic product (GDP) and electricity generation are shown in Table 7:

Table 7 – Results of ARDL Model

Variables	Coefficients	Standard Error	t-Values	Probability
@TREND	-0.065290	0.054511	-1.197732	0.2427
ELECT(-1)	0.968849	0.389503	2.487395	0.0202
GDP(-1)	0.227378	0.247807	0.917561	0.3680

In the above table, the ARDL equation results are measured. Trend is considered as the constant and it will not be discussed.

If there is one percent increase in the electricity generation, then it will lead to 97 percent increase in the GDP. The value of t-statistic shows that results are statistically significant and this implies that a long run relation exists between the electricity and GDP.

4.4. WALD TEST:

Wald test is used to restrict the coefficients in a model. In ARDL, Wald test is applied to check the long run impact of the variables. Wald test in ARDL, calculates the F and Chi square stat for showing the long run impact.

Table 8 – Results of Wald Test

Test Statistic	Value	Degree of freedom	Probability
F-statistic	6.187135	(1, 24)	0.0202
Chi-square	6.187135	1	0.0129
Order of Lag	1		
Upper Bound Value (0.05%)	3.56	Lower Bound Value (0.05%)	1.98

Above table is showing the F-stat value of Wald test for ARDL model. If the F-stat value is greater than the upper bound and lower bound value, then there is long run relationship between the variables. But if the value is less than upper and lower bound values, no long run relationship prevails between dependent and independent variables. If it lies between upper and lower bound values, then there are spurious results.

By looking at the above table, it is found that the F-stat value is 6.187135, which is greater than the upper bound value 3.56 and lower bound value 1.98. So here, null hypothesis will be rejected and it is proved that there is long run relationship between GDP and electricity generation. This also shows that electricity plays an important role in the economy of any country and it is very important factor of the modern age.

5. CONCLUSIONS:

Presently, Pakistan is facing the extreme shortage of electricity and this shortage is effecting the economic growth of the country. House hold, industries and many other parts of economy are suffering due to this shortage of electricity. The purpose of this study was to check the impact of coal on electricity generation and the impact of electricity on the economic growth of Pakistan by using the period data from 1981 to 2011. By utilizing the Co-integration and Auto Regressive Distributive Lag Model techniques, the impacts were shown. It was found that coal, hydel, gas, oil and nuclear, all have positive, significant and long run impact on the electricity generation by using Co-integration technique. By utilizing the ARDL approach, it was found that electricity generation has the positive and long run impact on the economic growth of Pakistan.

So, it can be concluded that coal has positive and significant impact on the electricity generation, as other resources have on it. By utilizing the coal, electricity can be generated for the long run. By generating electricity from coal and other resources, the economy of Pakistan will boost and it will be effective for the people of Pakistan. By producing electricity from coal, energy problems of the country can be resolved.

6. RECOMMANDATIONS:

a. Thar coal fields are found to be more reliable and effective for long run electricity production. Government should start working on this project for getting the cheap electricity.
b. Government should try to reduce the load of electricity generation from oil and gas, and it should be converted on coal and nuclear.
c. Government should provide all related facilities for generation of electricity from coal to the scientists, who are claiming that they can produce electricity from coal as soon as possible.
d. Private sector and foreign companies should invest in the Thar coal fields for the generation of cheap and effective electricity.

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