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Research Article **Open Access**

ELECTRICITY GENERATION AND ENVIRONMENTAL DEGRADATION IN PAKISTAN

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Abstract

The main objective of this research paper is to analyze the electricity generation and environmental degradation in Pakistan. In this study we have used secondary data for the period from 1971 to 2018. The dependent variable was Environmental degradation (Co2) and independent variables were: Electricity generation (EG), Electricity generation from oil (EO), Electricity generation from natural gas (ENG), Electricity from nuclear (ENU). The analytical techniques used in this study were: ADF Unit Root test, Correlation analysis, ARDL model, Bound test, ECM and Granger causality test for analysis of data. The findings of this study show that there is a positive relationship between environmental degradation and Electricity generation (EG) from fossil fuel, natural gas and nuclear sources.

Key words: Energy crisis; Power generation; Environmental degradation

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1. Introduction

1.1. Background of study

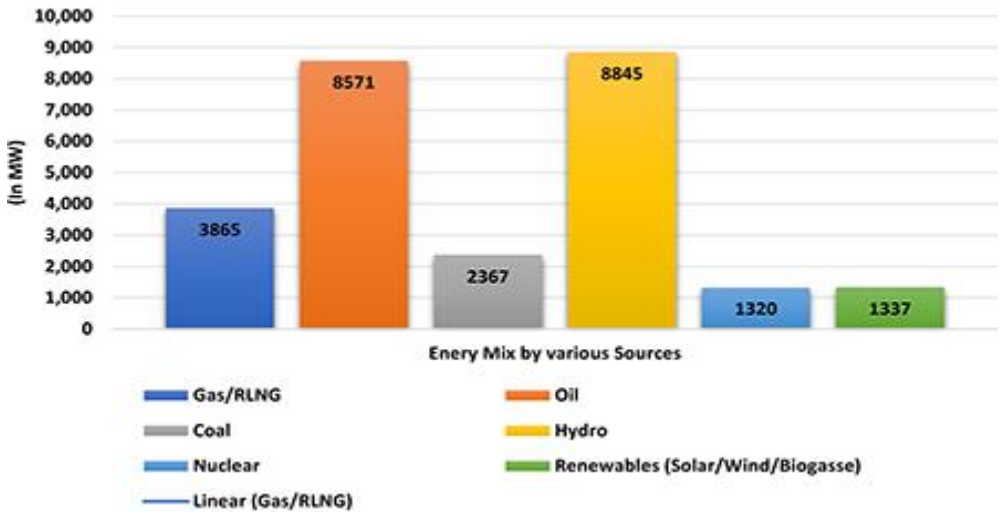
There is a need for proper analysis of the generation of electricity and the consumption of electricity to develop a balance. The increasing rise in the demand of energy plays an important role in motivating countries to increase their production of power. Energy and power have become the most important concern of the world and various innovative methods are being used to save and generate energy to meet the needs of the people. in the present era of automation, everything is being operated with the help of electricity and every country is trying to meet the energy demand. The Ukraine-Russia war has also enhanced trade-off between renewable and non-renewable energy resources and created a new complex situation for European countries which are mostly dependent upon oil and gas supply from Russia.

The nations that have a surplus amount of energy generation, are far ahead in development than other nations. Power generation and transmission system of Pakistan is very complicated due to monopoly of two companies, WAPDA and K-Electric, besides electricity generation by 42 independent power generation companies. If the statics are analyzed, it is evident that more than 99% of the population on average has an electricity supply. The maximum demand for electricity of domestic users and the industrial sector is nearly equal to 25,000 MW. The transmission and distribution capacity of Pakistan is only 22,000 MW and therefore, there is a gap of 3,000 MW between demand and supply.

The generation of electricity is significant for industrial and economic growth of country. If t Pakistan's case is analyzed, it is evident that Pakistan has always faced energy crises. The crises of energy have resulted in countless

problems for the nation. Since independence, Pakistan has been facing energy crises and it is one of the main hindrance in the path of progress. The statics show the total generation of power is nearly equal to 20100MW. Out of which Hydel power generation is 6500MW, while thermal power generation is 13000MW. Similarly, Nuclear power generation is 450MW while power generation through coal is 150MW. It means that Pakistan is generating electricity through different non-renewable sources. The ratio of power through hydropower is only 27 percent while remaining electricity is being produced from other non-renewal resources. The percentage of electricity generation by through different sources are shown in the Figure **1.**

Fig 1: Source of Electricity generation in Pakistan



Coal generation is one of the most important sources of generation of power globally. The statics of the International Energy Agency (IEA) depict that coal was considered an inexpensive primary energy generation source. The coal reserve was discovered in Pakistan in 1990 in Thar (Sindh Province).

Therefore, coal generation is an important and considerable option that could be taken in order to generate more electricity in Pakistan.

Pakistan's energy infrastructure is considered underdeveloped and poorly managed, rather than developed. The nation is increasingly experiencing a serious energy crisis. Despite strong economic growth and increasing energy demand over the decades, no significant efforts have been made to build new generation capacity on sustainable level. Rapid demand growth, as well as transmission losses, out dated infrastructure, are the factors causing low production and low distribution of electricity.

The main reason for the increase in the electricity demand is rapid population growth which is roughly between 2.5 to 3 percent per annum. The rapid increase in population causes rapid increase in electricity demand due to increase use of electric appliances. Similarly, agriculture and industrial sectors are also expanding rapidly the demand for electricity from these sectors are also increasing exponentially. In contrast, energy resources like natural gas is rapidly depleting and now Pakistan is importing LPG to meet the need of domestic consumers. Pakistan is spending from $10 to $12 billion on the import of oil and gas every year and this great burden on its budget and trade balance. It indicates that power shortage is a real phenomenon which need in depth research how to solve it. This is the reason we have intended to conduct research on this issue. Although Pakistan is trying to exploit renewable resources like Solar, Wind, tide and geothermal heat but is yet at primitive stage and their contribution in power generation is nominal. It will take a long time to use clean energy resources for power generation in Pakistan due to lack of resources, technology and human capital having relevant skill. This is the

reason that Pakistan is forced to use fissile fuel for power generation and it is also facing environmental degradation and rising level of emission.

1.2. Problem statement

The main research problem of this study is to find out relationship between electricity generation and environmental degradation in Pakistan and also to explore their causes and effect on the society. Electricity is the engine of economic growth and basic need of human being. The cost of energy use is rapidly increasing vis-à-vis per capita income of the people. Now the people are spending most of their income on electricity and petroleum products, and on account of this their purchasing power is decreasing and their health problems are increasing day after day. Now the major issue is how the cost of power generation is decreased in order to make the industry competitive and to increase real income of people to spend on other items. So we have intended to investigate the problem of energy shortage, its causes and its effects on the people and society.

1.3 Objectives of Study

The objectives of this study are listed below: -

- To analyze the impact of using fissile fuel in the generation of electricity and its impact on the environment.
- To analyze the association between demand and supply of electricity in Pakistan.
- To study whether fissile fuel is more efficient and cheap than other energy resources in electricity generation in Pakistan.
- To examine relationship between electricity generation and GDP growth.

2. Literature Review

Coutinho (2014) has investigated energy generation, consumption and energy deficit, which has paralyzed Pakistan's economy due to heavy load-shedding, closure of industries, mounting of circular debt and rising demand of electricity due to high population growth rate. He argued that the Government's all efforts to enhance power generation capacity has failed to end long load-shedding which is 16 to 18 hours daily in the rural areas. One can assess the economic loss and hardships being faced by the people due to shortage of energy. In 2010 there was 6000 MW gap between demand and supply but after eleven years it is still a gap of 3000 MW. He disclosed that most of the energy produced during last decade was based on thermal and coal resources which has caused environmental degradation. Lin (2020) examined the impact and consequences of renewable energy generation. This research was concluded that the potential for renewable energy resources is very high in Pakistan and it is blessed to have multiple energy resources like there is the potential of solar, hydro, biomass, tidal wind, and geothermal energy. In the research, secondary data is collected and analyzed. In the research, the impact of the energy generated by coal on the economy of the nation is analyzed. In the research, independent variables include coal and energy resources while the dependent variable is taken as electricity. The method that has been applied in the research is based on the Ordinary Least Square‖ Method by using 13 year data. The positive impact of Renewable energy generation is that it could help to increase grid credibility. The other important advantage of Renewable energy generation is the fact that it is an environmentally friendly mode of generation and there is a need of supporting Renewable energy generation for sustainable power production and have a positive environment. Nasim (2020)

investigated the impact of electricity generation on the economy of Pakistan. This paper compares the generation of power by coal and analyzes it impact by using time series data for the period from 1999–2018. The main aim of conducting the research is to examine the influence of various factors on the generation of Coal energy in Pakistan. As far as the results are concerned, it is noted that there were various negative effects of power generation through coal in Pakistan. Nasim (2018), also argued that Pakistan has been unceasingly striving in order to increase coal application in the power sector because as compared to other means of power generation, coal power generation is relatively cheaper. In the last ten years, the government is playing a great role in promoting coal power generation through its various programs like the Alternative Energy Development Plan (AEDP). In addition to it, the government of Pakistan played a role in increasing the utilization of coal in power generation in programs like China Pakistan Economic Corridor (CPEC) project. Increasing the integration of coal in the power generation system will not only play a significant part in enhancing the power generation capacity but will also significantly boost Pakistan ‘s economy. There are many important types of research that have clearly indicated the fact that coal power generation is a better and more cost-effective solution. Kumar (2019) has estimated a simulation model for thermal performance prediction of a coal fired power plant. It was examined that with the increasing demand and utilization of coal in various sectors, Pakistan will reach the crowning of coal procedure in the year 2025. The research emphasizes that as there are very serious energy crises that Pakistan is facing currently, therefore it is the need of the hour that proper investigation is carried out to explore energy resources. The research of Intended Nationally Determined Contributions (INDC) highlighted the fact

that due to the increasing power crises in Pakistan, the most suitable option for Pakistan is to achieve self-sufficiency in energy resources. Various domestic energy resources available in Pakistan are coal, hydro, and renewable energy. Ali (2019) depicted that coal demand in various developed nations is decreasing due to increased environmental concerns. In China, the use of coal in the power system is reduced by 2.1% but on contrary, the coal utilization will increase by 3.5% in the year 2017.The research of time-series study of coal consumption of Pakistan in the year 1974–2010.Satti (2017) examined the consumption of coal in Pakistan. The research aimed at forecasting coal consumption causality. The research includes a detailed overview of the comparison of the potential and feasibility of using hydroelectricity and coal power generation in Pakistan. The research concludes that although hydel energy is more cost-effective it requires huge initial investments and for a country like Pakistan, it is very difficult to achieve therefore it is desired that coal power production plants could be installed to meet the growing energy needs of the nation.

3. Research Methodology

3.1 Research Design

In this study we have used annual time series data for 37-year period from 1971 to 2018 to find out relationship between electricity generation and environmental degradation in Pakistan. The variables included in the model are: environmental degradation, electricity production, electricity from oil, electricity from nuclear, electricity from natural sources. The research considers the Variable "Environmental degradation (Co2)" as dependent variable while all others are independent variables. We will test this phenomenon by taking data from real life whether it is true that a mall change

in the quantity of fissile fuel brings significant change in environmental degradation.

3.2 Conceptual Model

The conceptual model illustrates relationship between dependent and independent variables. The dependent variable is the environmental degradation Co2 and the other variables such as the electricity production, electricity from oil, electricity from nuclear, electricity from natural gas are the independent variables.

3.3 Formulation of hypotheses:

There were two hypotheses used in the analysis. We can make hypothesis according to results and discussions of the theories. Energy consumption, renewable resources of energy, Demand and supply of electricity and Environmental degradation are mostly discussed in the theories on electricity generation and environmental degradation.

Ho = There is no long run association between electricity generation through fissile fuel and environmental degradation in Pakistan

H_1= There is long run association between electricity generation through fissile fuel and environmental degradation in Pakistan

3.4 Econometrics model

The econometric model of this study is given below: -

Environmental degradation=β0+β1(Electricity generation) +β2(Electricity from oil) + β3(Electricity from nuclear) +β4(Electricity from natural gas) + Uit. This model is shown in the following equation form: -

$$Y = \beta 0 + \beta 1\ X1 + \beta 2\ X2 + \beta 3X3 + \beta 4X4 + Uit$$

Where,

Y = Environmental degradation

X1 = Electricity generation

X2 = Electricity from oil

X3 = Electricity from nuclear

X4 = Electricity from natural gas

Uit = Error term

3.5 Analytical techniques

We have used the following statistical techniques to analyze data: -

- Descriptive statistics
- Correlation Analysis.
- ADF Test.
- ARDL Approach

4. Empirical analysis

4.1 Descriptive statistics

The descriptive statistics is used to check the nature of the normality of the data and examine the value of mean, median, maximum value, minimum value, JB value and the probability of the variables. The results of descriptive statistics are shown in Table 1.

Table 1: Results of Descriptive analysis

	ED	EG	Nu	EO	ENG
Mean	0.614255	56.19736	2.424995	22.46302	33.47820
Median	0.630000	58.40898	1.766067	22.38777	31.73897
Maximum	0.950000	71.82600	6.085907	39.69444	50.76785

Minimum	0.300000	37.99596	0.013356	0.303372	25.03097
Std. Dev.	0.192113	10.15917	1.768058	13.44510	6.616388
Skewness	-0.057969	-0.249565	0.600565	-0.218646	0.781811
Kurtosis	1.886464	1.621805	2.053581	1.540368	2.743620
Jarque-Bera	2.454582	4.207584	4.579407	4.546758	4.916675
Probability	0.293086	0.121993	0.101296	0.102964	0.085577
Sum	28.87000	2641.276	113.9748	1055.762	1573.475
Sum Sq. Dev.	1.697749	4747.599	143.7973	8315.451	2013.723
Observations	47	47	47	47	47

Table 1 shows the descriptive analysis of the variables. In this table the dependent variable is the ED and the average value of the ED is the 0.614255, maximum value is 0.95 and minimum is 0.3. The skewness value the ED shows that the ED is negatively skewed. The ketosis value of the ED is less the 3 which shows that the ED is plato kurtosis. The JEQUE Bara value of the ED shows that the ED is not normally distributed. THE mean value of Nu is 0.2.24, maximum value is 6.08, minimum value is 0.01 and the standard deviation of the data is 1.76. The Skewed value of the Nu shows that the Nu is positively skewed. The kurtosis value of the Nu is less than 3 shows that the Nu is PLATO kurtosis. Similarly, the value of the JB shows that the Nu is normally distributed. The KUTOSIS value of EO is less than 3 indications that the EO is the plato-kurtic. The JB value of the EO 4.5 is indicating that the EO

is normally distributed. The mean, maxima, mini values of the EO are 22.46, 39.69, 0.303. The kurtosis value of the EG is 1.6 which is less than the 3 it means that the EP is Plato kurtosis. The JB value of the EG is 4.2 indicating that the EP is normally distributed. The mean value of EG is 56.19, maximum value is 71.82 and minimum value is 37.99. The EN is normally distributed because the value of the JB is 4.9 and the kurtosis value of the EN is the 2.7 indicating that the EN is the platokurtosis. The JB value of the EN is indicating that the EN is the normally distributed.

4.2 Correlation Analysis

The correlation is used to check the degree of the association between variables. The range of correlation lies between -1 and +1. There was error in the measurement in correlation when the calculated value is greater than 1. There are the two type of the correlation: negative or positive c. The results of correlation analysis of this study are shown in Table 2

Table 2: Results of Correlation Analysis

Variable	ED	EG	Nu	EO	ENG
ED	1.000000				
EP	0.82	1.00000			
Nu	0.26	0.22	1.00000		
EO	0.52	0.81	0.18	1.000000	
EN	0.42	-0.27	-0.02	-0.67	1.00000

Table 2 shows the correlation between selected variables. The 1st variable which is environmental degradation (ED) shows the positive correlation with electricity generation and the value of correlation is 0.8. Environmental degradation (ED) shows the positive correlation with electricity generation from nuclear source and the value of correlation is 0. 26.. Correlation between the ED and electricity generation from oil shows the positive correlation between these two variables and the value of correlation is 0.52. ED and electricity generation from natural gas shows the negative correlation between them and the value of correlation is -0.42. It short, all independent variables have positive correlation with environmental degradation except natural gas. It means that electricity generation from natural gas does not cause environmental degradation. The positive coefficient values of all other independent variables show that electricity generation through them will cause environmental degradation.

4.3 Augmented Dickey Fuller (ADF) Test

The ADF is used to check the stationarity between selected variables. If the coefficient of the variable has the "spurious regression" problem than the assumptions of the BLUE are not satisfied. To remove this problem of the spurious regression the ADF test was developed. The Augmented Dickey Fuller (ADF) test is based on following equation

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \varepsilon_t$$

Where Δ= operator of the first difference

^{p} = Operator of the lag

^{t} =time

€= The error term

There are three possibilities of the ADF test which are given below

- Without trend and intercept
- With trend and intercept
- With intercept.

ADF test has three form such as,

1. Without intercept and trend,

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y + \varepsilon_t$$

2. With intercept,

$$\Delta Y = a_0 + \gamma Y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Y + \varepsilon_t$$

3. With intercept and trend,

$$\Delta Y_t = a_0 + \gamma Y + \beta t + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \varepsilon_t$$

From above general form of equations, ADF test is performed at level and 1st difference. The two main hypotheses are made such as 1st is the null hypothesis in which the under estimated variable has united root and the 2nd is alternative hypothesis in which the under estimated variable has not united root.

- If the t-statistics value is greater than the critical ADF test value, then the null hypothesis is accepted. Then the result is that the variables are not stationary.
- If the t-statistics value is less than the critical value of ADF test value, then the null hypothesis is rejected as the variables are stationary. The calculated results of ADF Test are shown in Table 3.

Table 3: Results of ADF Test

Variables	Level	1st difference					Result	P-Value
	Intercept	T & I	Non	Intercept	T & I	Non		
ED	-2.176	-3.269	-2.602				L(0)	0.008
EP				-0.9550	-9.505	-9.110	L(1)	0.0001
ENG				-8.763	-7.804	-7.899	L(1)	0.0001
Nu				-4.007	-3.924	-4.090	L(1)	0.0031
EO				-5.662	-4.241	-4.581	L(1)	0.0002

The results in Table 3 show that all variables are the stationary point on level or on 1st difference. The results show that the ED is the stationary at the level while the remaining variables such as the EP, Nu, EO and EN are stationary at the first difference. We check the stationary on the basic of the t statistics and the probability value. When the probability value is less than 0.09% then the variable is stationary and the stationary of the variable is proved. As the results show that variables of this study are stationers at different level so we can use ATDL approach for analysis.

4.4 Auto Regressive Distribution Lag (ARDL) Model

The auto regressive distribution lag model is used to investigate long run association between variables. The ARDL model is basically OLS based model which include both the non-stationary time series data and the time series data with the mixed order. The first step in the ARDL is to calculate the

bound test to confirm the long run relation between the variables. There are the following steps of the ARDL Model Bound test and after that long run short sun association between variables are checked.

4.4.1 Steps of the ARDL Model

There are three steps in the ARDL model which are as follows: -

- Bound test
- Long run association
- Vector error correction model

4.4.2 Bound Test

The bound test is used to check the long run relationship between variables. We set Anaika info criteria to find out the long run relationship between variables. Persian was the first person who introduced the Bound Test in 2001 to examine the long run association between variables. The basic objective of the Bound test is to check the presence of the co integration. In the Bound test the F statistics is used to compare with the tabulated f statistics critical values. There are the two set of critical values which are given below

- Upper value bound (1)
- Lowe bound value (o)

When the significance of F statistics is greater than upper bound test of the tabulated F value it shows the presence of co integration between variables. When the estimated value is less than lower boundary value it will show there is no co integration between the variables. The calculated results of Bound Test are highlighted in Table 4.

Table 4: Results of Bound Test

F-statistic	**2.7249**	
Significance	**LB**	**UB**
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68

H_0 = there is no long run association or no co integration

$$\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6$$

H_1 = there is a long run association.

$$\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq \lambda_6$$

From the above table it is clear that the long run association between variables exists as the value of the F stats is greater than lower bound and less the higher bound at 10% and the 5% level. As F statistics is greater than the lower bound and less then upper bound at the 5%, we can reject null hypothesis and accept alternative hypothesis that there is long run relationship between variables.

4.4.3 Long Run Relationship

The estimated long run relationship between variables are shown in Table 5

Table 5: Long Run relationship between variables

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EG	0.136508	0.049199	2.774614	0.0135
NU	0.043216	0.012817	3.371673	0.0039
EO	0.148332	0.049587	2.991361	0.0086
ENG	0.141387	0.050073	2.823615	0.0122
C	0.118741	0.134840	0.880607	0.3916

Table 5 show the results of ARDL Model which reveals if one unit is generated through fissile fuel it will likely to cause 13.65 percent environmental degradation. It means if electricity generation is increased through non-renewable resources the environment will be worsen in the long run. Similarly, one-unit electricity generation through nuclear and oil the environmental degradation will likely to be increased by 4.32 percent and 14.83 percent respectively in the long run. Similarly, if one unit of electricity is produced through natural gas it will likely to cause increase in environmental degradation by 14.13 percent in the long run. It means that all variables of the study have positive association in the long run. In other words, if electricity is generated through Nuclear, Oil and Natural gas the environment will likely to be worsen in the long run. These findings are consistent with the result of Tiba and Omri (2016), Adams (2018) and Mahmood (2020),

4.5 Error Correction Model

This model was used by the by Sargan in 1964 to determine the short run relationship between variables. This model is helpful to check the

disequilibrium of model from one period to another period. This model also tells about the abnormality of variables which is towards the equilibrium or deviation from it as well as speed of adjustment.

The general form of the ECM as,

$$\Delta Z_t = a_0 + b_1 \Delta X_t - \pi \mu_{t-1} + Z_t$$

Here the

- b_1 is the multiplier which shows the short run relationship of variables
- Π shows the alteration effects of variables

Impact multiplier gave the idea of the instant change in Z_t which will cause change in X_t & feedback shows how much time is need to correct disequilibrium. It is shown in the following equation.

$$\mu_{t-1} = Z_{t-1} - \beta_1 - \beta_2 X_{t-1}$$

In above equation the β_2 having the long run effect on the variables (Hall (2006). The calculated results are illustrated in Table 6.

Table 6: Results of ECM

Variables	Coefficient	Std. Error	t-Statistic	Prob.
D(ED(-1))	0.390518	0.297779	1.311435	0.2082
D(ED(-2))	0.665235	0.268541	2.477221	0.0248
D(ED(-3))	0.353236	0.253648	1.392626	0.1828
D(ED(-4))	0.358862	0.341920	1.049549	0.3095
D(ED(-5))	0.571343	0.316621	1.804499	0.0900
D(ED(-6))	0.407347	0.265681	1.533219	0.1448
D(EG)	0.053175	0.026655	1.994928	0.0634
D(EG(-1))	0.065506	0.047003	1.393641	0.1825

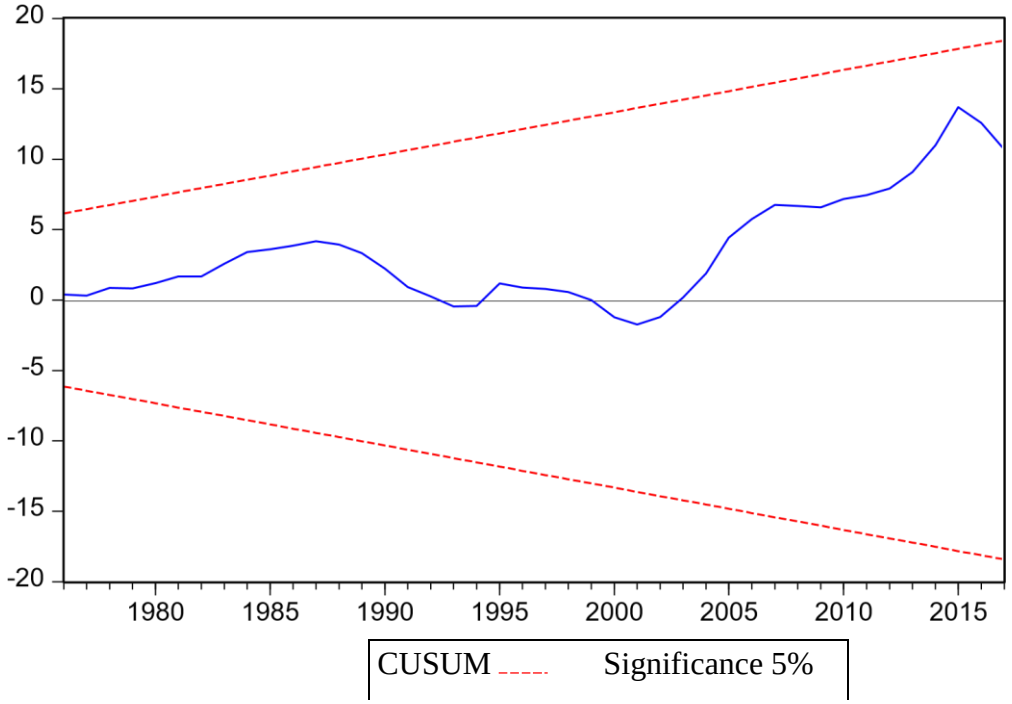
D(EG(-2))	0.013130	0.040112	0.327345	0.7477
D(NU)	0.001799	0.009051	0.198771	0.8449
D(NU(-1))	-0.003343	0.010274	-0.325429	0.7491
D(NU(-2))	-0.001890	0.007568	-0.249750	0.8060
D(EO)	-0.048485	0.026285	-1.844589	0.0837
D(EO(-1))	-0.064998	0.047108	-1.379781	0.1866
D(EO(-2))	-0.019715	0.040259	-0.489691	0.6310
D(ENG)	-0.052115	0.026591	-1.959854	0.0677
D(ENG(-1))	-0.067612	0.047471	-1.424295	0.1736
D(ENG(-2))	-0.014006	0.040410	-0.346608	0.7334
CointEq(-1)	-0.560260	0.245875	-2.278637	0.0368

The results of ECM model show that most of the variables have negative relationship with environmental degradation in the short run. As we use more non-renewable resources to generate electricity it will likely to cause environmental degradation and its effects will be minimal. But when we continue to produce electricity through non-renewable resources we will have to face environmental degradation as well as multi-dimensional effects on environment, human being and animals. So the short term gains will prove long term harm.

4.6 Stability Test

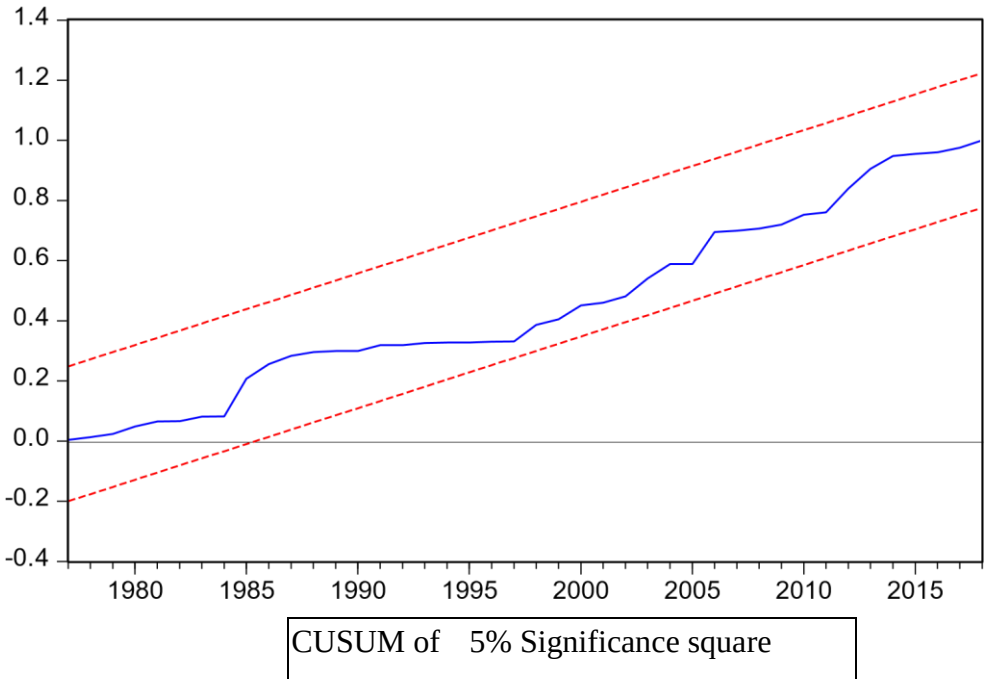
The stability test of the short run and the long run is explained with the help of the stability test such as the CUSUM test and CUSUM square test.

Fig 2: Cu sum Test



In the CUSUM test the blue lines must be in between the two re lines shows the correctness and stability of the test.

Figure 3: Cu sum of Squares



The cumulative sum of squares is generally within the 5% significance lines, suggesting that the residual variance is somewhat stable. Figure 2 illustrate that the blue line is not out of bound this indicates that the model of the study is reliable and significantly statistically.

5. Findings of study

The findings of this study are given below: -

- The results confirm that there is a positive and significant relationship between environmental degradation and electricity generation through gas, nuclear, and oil sources at a 0.05 level of significance level
- The mean, maxima, mini values of the EO are 22.46, 39.69, 0.303. The kurtosis value of the EP is 1.6 which is less than the 3 it means that the EP is platokurtosis.

- The mean value of Nu is 0.2.24, maximum value is 6.08, minimum value is 0.01 and the standard deviation of the data is 1.76.
- If one-unit increase in Electricity generation through fissile fuel it will likely to cause more than 14 % environmental degradation. For example, if we use oil, nuclear and natural gas for electricity generation the environment will be worsen in the long run. These findings are consistent with the study of Aloisi and koos (1996). In other words, environment cannot be kept clean when we are using non-renewable resources.

6. Conclusions and policy implications

Energy and power have become the most important concern of the world due to its high and volatile prices. It causes wild fluctuations in the economies which are dependent on non-renewable energy sources and are spending billions of dollars every year on its imports. Another negative effect of the excessive use of non-renewable resources is environmental degradation. There are various innovative methods and technologies that are being used in different countries to save existing natural resources and generate electricity to meet the needs of the people through renewable resources. But the developing countries like Pakistan has neither renewable resources in abundance nor it has clean energy technology It has to import oil of about ten to twelve billion US dollar every year. It is a huge cost bearing the country and most of the time it has to borrow loans from international donors to bridge gap between its tax revenue and public spending. Sometime, it has to import oil on credit for short-term period from friendly countries. The generation of electricity through non-renewable resources are also causing environmental degradation and depletion of previous natural resources, which have posed serious threat to country survival. For example, the production of agriculture

crops is rapidly decreasing due to shortage of water, seeds and fertilizers and Pakistan has to import food items from other countries. The environmental degradation has caused serious challenge for the policy makers how to control rapidly depletion of natural resources. Currently, the policy makers have overlooked environmental degradation just to meet growing demand of electricity and for production of electricity they are using even coal at large scale. Similarly, Pakistan is one of the biggest producer of Cement and the whole cement industry is also using local and imported coal. It is polluting environment and creating hazardous for the people, plants and animals.

The practical implications of this study are stated as under: -

● There is a need for improvement in the generation of electricity in Pakistan in order to meet its growing demand. But the gap between demand and supply may be met through developing renewable resources.

● Most of independent power producers are generating electricity through furnace oil which produces high level of emission. They must be encouraged to use clean technologies for electricity generation.

● As the population is rising rapidly the demand of electricity is increasing rapidly. It is an imperative need to control population and encourage people to use electricity efficiently to reduce the cost and consumption.

● The Government of Pakistan is spending hundreds of billions of Rupees on health care to provide treatment facilities to the people to be effected by environmental degradation. These funds may be utilized on importing clean technology to keep the environment clean and to save the people from negative effects of environmental degradation.

7.Contribution of this study

This study highlights the fact that increase in electricity generation through non-renewable resources will cause environmental degradation. In order to save environment policy initiatives should be taken to use renewable resources and clean energy technology. This study also endorsed previous findings on this topic which reveal that the use of nonrenewable resources is harmful for environment, human being, animals and plants, so they may be replaced with renewable resources.

This study also highlights the problem of developing countries like Pakistan where population is growing very fast while natural resources are depleting rapidly. This situation has created a horrible future scenario and demands for immediate actions on the part of policy makers. This study also reveals that excessive use of oil and gas for electricity generation by Pakistan will increase debt burden and import bill. This study draws the attention of the policy makers to focus on long term goal of clean environment rather than focusing on short term goal of generating electricity through non-renewable resources in order to meet growing energy demand. They must consider that this short term gain can become a long term loss if they do not shift their strategy. This lesson is not only for Pakistani policy makers but also for all energy-deficit countries. They should learn lesson from the European countries which are dependent upon Russian energy resources because in past they did not pay much attention on the development of renewable resources. Now they have shifted their policy to exploit renewable resources and reduce dependence on Russian oil and gas after its invasion on Ukraine. There is a valuable insight of this study for political leaders and policy makers to pay full

attention on exploitation of renewable resources in order to save the world from environmental degradation and high cost of non-renewal resources. This is the only way to keep the future of coming generation safe and to achieve sustainable economic development.

8 Limitations and future direction of research

In this study we used the time series data ranging from 1971 to 2018. Generation of electricity is very difficult to measure so our data set are very limited time range and only on Pakistan. The local renewable resources will not overcome the shortfall in electricity supply but will play a key role in enabling Pakistan to harness energy effectively The research emphasized the fact that coal generation is a very cheap and reliable source for Pakistan. If the case of Pakistan is analyzed, it is evident that Pakistan has always faced energy crises. The crises of energy have resulted in countless problems for the nation. Therefore, there is a need of taking proper steps to resolve the energy crises in Pakistan.

Data Availability statement

The data used in support of the findings of this study will be available on request.

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Contribution of Authors

Both authors jointly carried out this research study and collaborated each other. The author 1 collected data, conducted its statistical analysis. He prepared initial draft of manuscript. The Author 2 helped Author 1 in selected of title of research, guided in statistical analysis and formatted final draft of manuscript. Both authors carefully read final draft of manuscript and find it fit for publishing. Both authors fully followed ethical values during the course of this research work.

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