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THE ROLE OF RENEWABLE ENERGY SOURCES IN ENERGY IMPORTS: EVIDENCE FROM BRIC COUNTRIES

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ABSTRACT
There is less debate on the connection among energy import and renewable and conventional energy sources in past studies. In direction to accommodate the excess demand of energy (electricity) the means beside conventional power generation sources, the natural energy sources are pivotal need of the world. On the other hand, developed and developing economies are under the huge burden of energy debt which is another dilemma. The study uses time period from 1990-2018 by using secondary data. To study the influence of renewable and non-renewable energy sources on energy import, the present study employs Panel Fisher Cointegration and Panel VECM technique. The empirical results support that electricity generation by oil source, renewable energy sources, and nuclear source decreases energy import and have significant casual effect in case of BRIC nations. Furthermore, the result reveals that electricity generation from hydro, coal and natural gas due to huge investment and initial energy utilization for the installation of nuclear plants, is not an efficient way. Therefore, BRIC nations need to explore and invest in renewable energy sources as well as nuclear and oil sources in order to fill excess energy gap along with lowering energy imports.
Keywords: *Renewable energy resources; Conventional energy resources; BRIC nations; Energy Imports; Johansen Fisher Cointegration; VECM technique.*

1. INTRODUCTION:

The BRIC nations as their names denotes, Brazil, Russia, India, China the four growing economies explicitly from last many years. These nations kept rapid pace of growth rates and sustainable advancement from several previous years, but therefore for continuing this progress these nation relay on renewable and non-renewable resources. Otherwise there is huge burden of energy import can ruin the pace of accelerated growth.

Considering the early times, use of energy possesses a fundamental role in individual's life. The discovery of electrical energy along with considerable use of fossil energy which directed to the commercial innovation. It leads to advancement involving science along with technological know-how, enhanced a higher level of socio-economic prosperity and upgrading living standards. Developing nations are usually in dynamic energy crisis. BRIC nations spends quite much 7 billion dollars US$ upon import regarding fossil heats up yearly for meeting the energy needs. The renewable energy is also eco-friendly energy resources and greatest substitute to the traditional ecological warmth (Wu et al., 2017).

However, the use of energy is still a critical component pertaining to rapid socio-economic progress. The economic progress involving prior changes that provides major improvement in order to get immense material well-being, and most of these changes are already significantly appears in economies structures. Energy sector of the economy is considered as "oxygen" as well as the lifeblood involving in the growth or progress. It integrates a crucial function in economic growth inside a country. It improves the performance and production in the country and plays a vital purpose to pertaining the people Shahbaz et al., (2017).

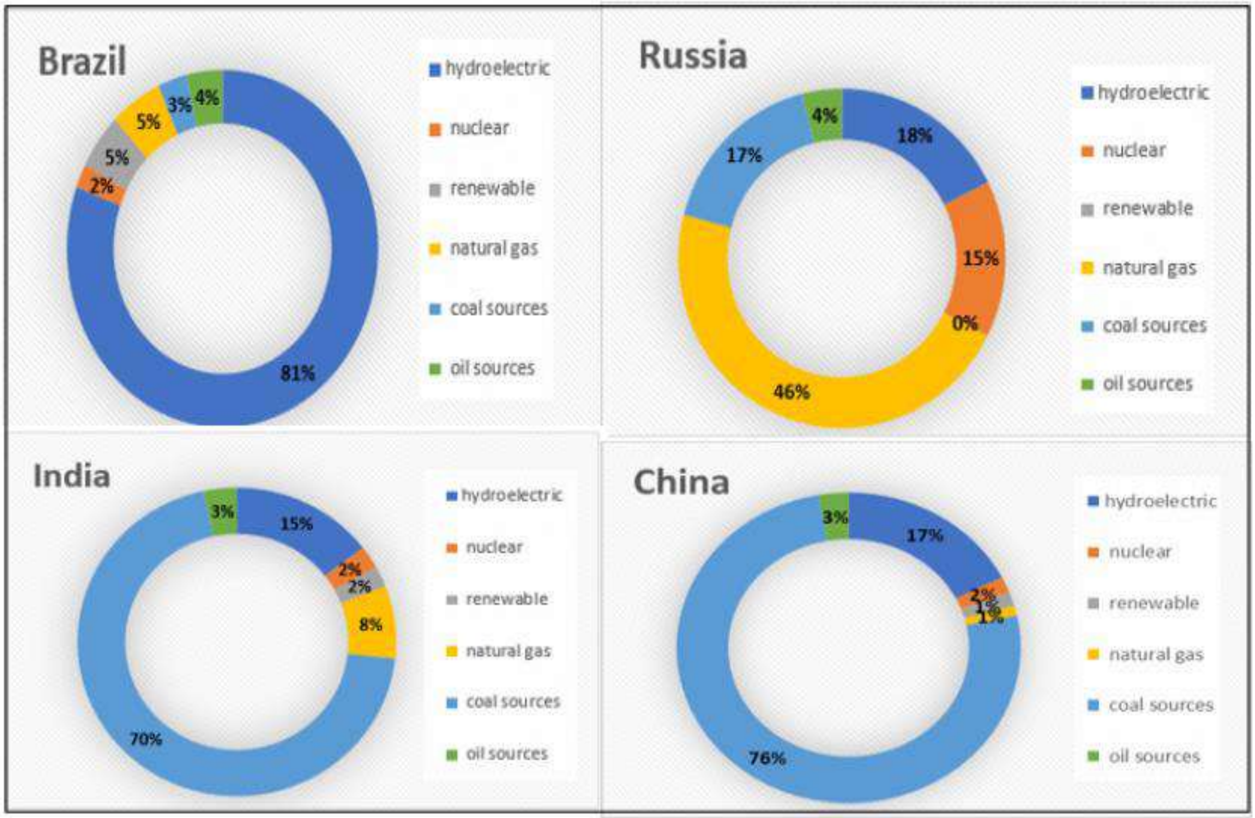
The particular fiscal balance of developing countries such as BRIC nations are dependent on the advancement of the energy sector in addition to long-term planning using household energy resources. Additionally, BRIC nations has suffering an unmatched energy debt and immense need of energy given from last number of years. The ability sector (electricity sector) received huge attention, as it has higher level of advancement. The governments placed most projects to manage the energy sector problems but however, the issues will not be over. As the issues provides plagued each one, thus dealing with energy issues bought fast problem with manifestos of most governmental situations, experts in addition to Financial experts (Banshwar et al., 2018).

The renewables energy sector as part of total worldwide energy demand is projected to fulfil for upcoming five years. In the electricity generation sector, these sources have the fastest growth and contributing nearly 30% of energy demand in 2023. Up to this timeframe, renewable sources are estimated to meet world electricity production demand by solar PV 4%, wind 6%, hydropower 16%, and bioenergy 4% (IEA, 2018). Brazil has huge hydro energy sources and renewable energy reserves that meets about 90% of the power demand of the nation. India promoted nuclear energy generation and advance solar system and will has 5th major wind energy sector by 2022. With these energy reserves, the country will tackle energy shortage. However, energy transformations are still a great problem. Finally, Russia depends on the conventional energy sources whereas, 16% of the overall electricity generation of the nation meet by usage of renewable sources. Hydro and geothermal power systems are the main sources of energy production (Zaman et al., 2016).

According to IEA (2018) report, bioenergy is the major and predominant sub part of renewable energy. The global renewable energy resources up to 2023 for electricity generation would be modern bioenergy sources. The report also highlights market improvements that can reveal further prospective for growth in renewable energy of electricity generation and transport biofuels sources.

Bioenergy production is essential factor regarding the nation's progress by improving GDP growth rates. It has fundamental role in both domestic and international markets such as energy importing nations. In general term, biomass is improved and efficient way of electricity generation due to fossil fuel and important substitute are capital intensive (Toklu, 2017). The better usage of bioenergy indicates extensive geographical supply, and variety of feedstock, secure power supplies in small budgets for the bright future in long run (Domac et al., 2005). BRIC nations have prospect to practically produce biogas from animals' manure. So, this can produce 16.3 million biogases in one day and 21 million tons of bio fertilizer in one year. This compensate almost phosphorus (66%) and nitrogen (20%) essential for the crop fields (Zhang et al., 2018).

Electricity generation during 1980-2018 for BRIC nations



The production of electricity main focused by hydro sources in Brazil from last three decades. This method of power generation is clean and subpart of renewable energy sources. The analysis results also support this production method through hydro plants for overcoming the energy debt and energy import. This will help to meet the energy demands at national level and the facilitating the neighbouring countries e.g. Paraguay.

Russia has huge reserves of coal and natural gas which also exports to other countries. Russia exports greatest amount of fossil fuels to Germany. Russia is richest country of conventional sources and focuses generation of electricity and energy by them. The hydroelectric sources about 17 %. 46% of electricity is produced through mainly from natural gas, this is reason coal and nuclear sources usage for power generation has dropped to some extent low to 17% and 15% correspondingly. The total energy generation by conventional sources are about 70% and the renewable sources are neglected. So, Russian government should focus and pay attention towards the usage of renewable energy sources. India and China have highest coal energy reserves. The demand for energy is going to increase day by day due to increasing population for China and India. This will increase the energy import that becomes much costly. There is need to install power plants that requires huge investments. India and China have largest coal reserves that can be utilized for energy generation. India used 306 GW of total energy by thermal plants that degraded environment heavily. This is good time to explore renewable energy forms (wind, solar, hydro and biogas) for power generation rather than coal sources because it will be face severe shortfall in future (Kurtkoti, 2016).

Russian economy is supported by Banks which offers loans for investment to renewable energy makers. The loans use for stimulating private sector investment and rise electricity production up to 4.5% by the year 2020. The World Bank also encourages Russia Renewable Energy

Program (RREP) for investing in this sector. Similarly, Indian economy also receives loans at lowest interest rates for usage of renewable sources and electricity production from small wind farms and hydro projects via agencies. The National Development Bank is answerable and offering loans at 6.4% interest rate for solar energy projects in Brazil for investment in renewable energy in order to meet national energy demand. Banks loan are financial sources for renewable energy sectors (Wind energy) in China. Policy banks sanction loans at low interest rates for natural energy sector and commercial banks incline to towards profitable plans. The investment made in photovoltaic industrial sector due to the greater returns Zeng et al., (2017).

The existing energy demand scenario much exceeds its indigenous supply, encouraging dependence upon increased in import which places huge burden on BRIC nations.

1.1 SIGNIFICANCE OF THE STUDY

Energy sector has great importance for any economy's progress and future prosperity. BRIC nations are leading prospers nation that could achieve higher economic growth rates in coming few years. Energy sector is basically represented by energy (electricity) production from different renewable and conventional sources. This research analysis has greater significance that either which energy sources are more economic efficient or highly utilized by the economies to achieve lower energy imports. This will contribute higher economic growth rate and lowers energy debt. This research opens the new dimensions for investment and exploration of renewables sources and significant conventional energy sources that would meet the energy demands.

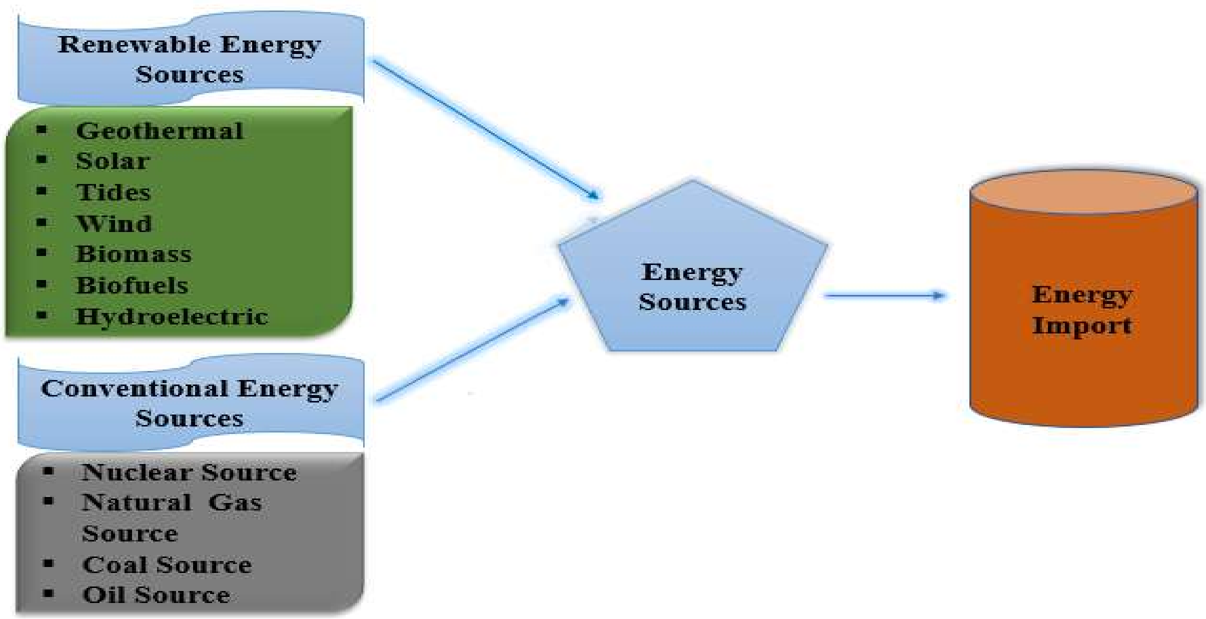


FIGURE 1: RESEARCH FRAMEWORK

Source: Self-Abstract

1.2 OBJECTIVES OF THE STUDY:

The purpose of this analysis is to explore empirical relationships.

1. To access the statistical associations among energy import and renewable energy sources.
2. To access the statistical associations among the energy import and conventional energy sources.

2. LITERATURE REVIEW:

A large number of studies have been carried out to show how energy import can be reduced and related by energy production from conventional and nonconventional energy resources. Akash et al., (1999) calculated a comparison of electricity generation among different energy resources in Jordan for the time period 1996 to 1999. By employing Analytical Hierarchy Process (AHP) methodology the empirically results shows that wind, solar and hydropower is the greatest substitutes for electricity energy production. Nuclear electricity and fossil fuel have the worst choice whereas, these power plants have highest cost, with values 0.429 and 0.337 respectively in power generation sector. On the other hand, solar sources, wind sources and hydro sources have lower values lies between the range of 0.077 and 0.079. So, this study recommends government should invest and explore the renewable energy sources for power generation. Qudrat-Ullah & Davidsen, (2001) calculated the dynamics of electricity supply, resources and pollution in case of Pakistan for the time frame 1980 to 1995. By using Dynamic simulation model, the association among electricity demand, investment, capital resource, production, environment, costs and pricing sectors examined. The econometric result shows that the unchanged prolongation of the prevailing policy seems to effectively attract IPPs investments but not without potentially adverse penalties for the environment and the economy. Larson et al., (2003) studied the future inferences of China's energy-technology choices. The results indicate a business-as-usual strategy that count on coal combustion technologies would not be able to meet all environmental and energy security goals. Ogulata, (2003) studied the energy sector and wind energy potential in Turkey for the time period 1985 to 2000. The aim of this study is to presents the dominant and the expected energy situation and energy demand. The energy forecasted model shows that Turkey's consumption of electricity is expected to continue to grow quickly at approximately 8% per annum. Electricity demand will increase to 175 TWh by 2005 and to 492 TWh by 2020. The annual oil demand is around 35 Mtoe and it accounted for 8.3% of oil consumption in 2000. In this decade, around 92% of the total oil demand was imported. Turkey has very restricted indigenous energy resources and must import around 65% of primary energy to meet its needs. It is a large importer of primary energy despite having enough renewable energy sources. At the end of the year 2001, the total set up capacity of global wind energy exceeded 24,576 MW.

Shiu and Lam, (2004) study the causal relationship between electricity consumption and real GDP for China during 1971 to 2000. The results infer that real GDP and electricity consumption are cointegrated and there is unidirectional Granger causality running from electricity consumption to real GDP but not vice versa. Grubb at al., (2006) explore the relationship between low-carbon objectives and the strategic security of electricity in the context of the UK electricity system from time frame 1998 to 2005. The results indicate that low-carbon objectives are uniformly associated with greater long-term diversity in UK electricity generation. Asif (2009) explore hydropower, solar energy, and biomass and wind power as sustainable energy options for the Pakistan for the time frame 1980 to 2006. The econometric results found that the total estimated hydropower potential is more than 42 GW out of which only 6.5 GW has been nominated so far. In terms of obtainable solar energy, Pakistan is amongst the richest countries in the world, having an annual global irradiance value of 1900 to 2200 kWh/m^2. Nonetheless of that fact that the biomass plays a vital role in the primary energy mix by contributing to 36% of the total supplies, it has not accomplished to break into the commercial energy market. Wind power, also been acknowledged as a potential source of energy, is so far to blast-off.

Ma et al., (2009) investigate the demand of energy by using a two-stage trans-log cost function approach for the period of 1995–2004. The results suggest that energy is substitutable with both capital and labor. Coal is significantly substitutable with electricity and slightly complementary with oil, while oil and electricity are marginally substitutable. China's energy strength is increasing during the study period and the major driver appears to be due to the augmented use of energy-intensive technology. Popp et al., (2011) studied the investment in wind, solar photovoltaic, geothermal, and electricity from biomass & waste across 26 OECD countries from 1991-2004. The results accomplish that environmental policy appears to be more important, as countries that have approved the Kyoto Protocol invest in more renewable capacity. Investment in other carbon-free energy sources, such as hydro and nuclear power, assist as substitutes for renewable energy. Apergis et al., (2010) inspect the causal relationship between CO2 emissions, nuclear energy consumption, renewable energy consumption, and economic growth for a group of 19 developed and developing countries for the time period of 1984–2007 using a panel error correction model. The long-run estimates indicate that there is a statistically significant negative relationship between nuclear energy consumption and emissions, but a statistically significant positive relationship between emissions and renewable energy consumption. The econometric results from the panel Granger causality tests recommend that in the short-run nuclear energy consumption plays an important role in reducing CO2 emissions whereas renewable energy consumption does not contribute to declines in emissions.

Apergis and Payne (2010) examine the relationship between renewable energy consumption and economic progression for a panel of twenty OECD countries over the time period of 1985 to 2005 by using multivariate framework. The Granger-causality results indicate the bidirectional causality between renewable energy consumption and economic growth in both short- and long-run. These results restate that the benefits associated with such government policies as renewable energy production tax credits, rebates for the installation of renewable energy systems, renewable energy portfolio standards, and the establishment of markets for renewable energy certificates in diversifying the energy base of OECD countries. Chaudhry, (2010) analysed the nation-wide demand and the firm level demand for electricity in Pakistan by implying panel data from 63 countries from 1998-2008. The results indicate that the elasticity of demand for electricity with respect to per capita income approximately 0.69, which denotes that 1% increase in per capita income will prime to 0.69% increase in the demand for electricity. The firm level analysis indicates that the price elasticity of demand for electricity across all firms is approximately -0.57, which indicates that 1% increase in electricity prices will lead to 0.57% decrease in electricity demand across firms. Across sectors, the textile sector has the highest price elasticity of demand (-0.81) while the price elasticity of demand for firms in the electricity and electronics sector is the smallest (-0.31).

Amer and Daim, (2011) examined some renewable energy options for electricity generation for Pakistan that is explored from multiple standpoints comprising technical, economic, social, environmental and political aspects for the time period 2002 to 2009. The econometric results show that biomass energy and wind energy appeared as the preferred substitutes. Utilization of biomass energy on large scale can decline dependence on conventional fossil fuel in the country. Aslani & Wong (2014) attempted to analyse the role of renewable portfolio in the US energy action plan during the time frame 2010 to 2030. By using the system dynamics model to construct and to evaluate different costs of renewable energy utilization by 2030. The empirical results show that while renewables will create a market with near 10 billion $ worth (in the costs level) in 2030, the total value of renewable energy preferment and consumption in the US will be more than 170 billion $(in the costs level) during 2010 to 2030.

Corsatea et al., (2014) debated on the competitiveness and maturity of wind technology by carrying out an investigation on research investments and sales of panel including 10 wind manufacturers over the period 2002 to 2011. The aim of this analysis is to examine the extent to which public and private funding affect the competitiveness of wind corporations. A group of major manufacturers of wind turbines with production in 2006 totaling above than 70% of the world supplied capacities is considered as a representative cluster of green innovative industry. Incentives for the production of wind energy, Public support for research, development and demonstration (RD&D), and ingress to credit are the three main sources of finance addressed herein. For the investment and sales of wind turbines corporate debt is the primary factor supporting both wind technology research, while other sources of finance play a limited role. The decline in that source of finance has important repercussions for the development of wind energy. The econometric analysis suggests that regulatory risks play a key role for the development of wind technology, even stronger than the financial risk. The prior originates in unexpected decisions to stop subsidies (e.g. deployment ones), whereas the latter arise from obstructive access to credit.

Sasana et al., (2017) studied the link among fossil fuels (petroleum, coal, natural gas) and renewable energy sources to the economic growth for the time 1995 to 2014. By applying Fixed Effect Model (FEM) the results presented that usage of fossil energy, especially coal energy, significantly accelerate the economic growth in the BRICS countries. Baniyounes et al., (2017) analyzed the solar and wind energy sectors for Jordon. This study concludes that government must be explore the potential and make the availability to renewable energy resources. These energy resources are friendly to environment and helps to meet the high demand for energy in future.

Zabaloy & Guzowski, (2018) reviewed the importance of New Renewable Energy Resources and policies transformation from conventional to renewable energy for three countries of Latin America over the time span from 1970 and 2016. NRES has direct and positive relation to energy generation and it would lessen the dependency over the fossil and conventional means. The results indicated that Argentina lagged behind in a comparison of Uruguay and Brazil in power generation and policy transformation due to inefficiency and economic hurdles. Uddin et al., (2019) discussed the present energy sector scenario for Bangladesh. The economy mostly relied on natural gas for electricity generation about 65% so there will be shortage of reserves in future. On the contrary, there is only 3% power generation is done by using renewable energy sources. The present and future demands for energy would be fulfill by the saving and growing renewable sector including hydro, biogas, solar and wind etc. The suggestion mentioned is to invest and explore for renewable sources.

Based on above studies, it may conclude that the renewable energy source is the essential demand of the world. As the Electricity supply is considered as one of the indispensable inputs for any economic activity of developed and developing countries are alike. The propagation of suitable, electricity-based implements and the inadequate substitution possibility of electricity for many end-uses mean that undisrupted supply of electricity is a pre- requisite for modern economies. Consequently, make sure to affordable and consistent supply of electricity is one of the pre-occupations of the electric efficiencies.

3. DATA SOURCE AND VARIABLES DESCRIPTION:

The study uses annual observations for the period of 1990-2018. The data has been taken from World Development Indicator published by World Bank (2019). To examine the impact of energy import on renewable energy sources, the present study employs cointegration technique in which dependent variable i.e., energy import regress on conventional and renewable energy sources from the time period of 1990-2018. We have estimated a simple linear energy import, renewable energy and conventional energy sources nexus which has been specified as follows:

Energy Imports = β_0 + $\beta_1$coal sources + $\beta_2$natural gas sources + $\beta_3$nuclear sources + $\beta_4$hydro sources + $\beta_5$oil sources + $\beta_6$renewable energy sources

Where,

$$EI = \beta_0 + \beta_1 CS + \beta_2 NGS + \beta_3 NS + \beta_4 HS + \beta_5 OS + \beta_6 RS + \mu_t \quad \ldots\ldots(1)$$

Energy Import: Energy imports, net (% of energy use). Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport. In this study, we used net energy imports as a percentage of energy use. This study used energy sources i.e.,

- **Electricity production from Conventional Energy Sources:**
  - Electricity production from nuclear sources (% of total)
  - Electricity production from natural gas sources (% of total)
  - Electricity production from coal sources (% of total)
  - Electricity production from oil sources (% of total)

- **Electricity production from Renewable Energy Sources:**
  - Electricity production from renewable sources, excludes hydroelectric includes (geothermal, solar, tides, wind, biomass, and biofuels) (% of total)
  - Electricity production from hydroelectric sources (% of total)

4. METHODOLOGICAL FRAMEWORK:

The study has employed panel unit root test for measuring stationary series for the observed variables. For this purpose, the study employed Levin, Lin and Chu, (2002) and Breitung, (2001) panel unit root test for assessing unit root problem in the variable series. The null hypothesis of no unit root problem in the data series against evaluated with the alternative hypothesis of unit root problem. Breitung panel unit root test applied only for those variables that confirmed the null hypothesis of no unit root problem in the variable series. Subsequently, the study proposed to find the long-run relationship between the variables.

4.1 PANEL UNIT ROOT

For the Levin, Lin and Chu, (2002) panel unit root analysis, we considered the following autoregression to obtain the ADF test for each time series variables in the panel of BRIC countries. Suppose, there are "N" series i.e.,

$$\Delta q_{it} = \beta_{ir}{}' d_{tr} + \alpha_i q_{i,\ t-1} + \sum_{j=1}^{p_i} \gamma_{ij} \Delta q_{i,\ t-j} + \epsilon_{i\ t}, i = 1$$

where $dt_0=0$ or $dt_1=1$ or $dt_2=(1, t)'$. The choice of each $_{pi}$ based on AIC or SIC, or on sequentially testing the last coefficient of the $\Delta q_{i,t-j}$.

In Levin, Lin and Chu, (2002) panel unit root test, we further assumed that all the αi have a common value, therefore, the null hypothesis is tested against the alternative hypothesis which allows to control the Heteroscedasticity problem across the time series that pull up to the considered panel i.e.,

H_0: $\alpha=0$ vs H_1: $\alpha<0$.

The study employed another panel unit root approach i.e., Breitung panel unit root which suggested the following equation i.e.,

$$(DY_{it})^* = S_t\left[DY_{it} - (1/T - t)\left(DY_{i\ t+1} + \ldots\ldots + DY_{iT}\right)\right]$$

where, $S_t=(T-t)/(T-t+1)$, $Y^*_{it}=Y_{it-1}-Y_{i0}-((t-1)/T)(Y_{iT}-Y_{i0})$, DY_{it} =panel data has been differenced, i=cross-section identifiers and t=time series data and $T=2,\ldots.T^2$

The null hypothesis is rejected based on small values obtained from equation (3) below i.e.,

$$B_{nT} = [B_{2nT}]^{-1/2} B_{1nT}$$

where, B_{nT}=Breitung t-statistics, the following hypothesis has been evaluated under the B_{nT} (Breitung t-statistic) i.e.,

H_0: Panel data assumes common unit root process

H_1: panel data has not unit root

If B_{nT} is significant, then accept the alternative hypothesis i.e., panel data has no unit root problem, and if B_{nT} is insignificant, then accept the null hypothesis that is panel data contained unit root problem. So, this study results have no unit root problem.

4.2 FISHER COINTEGRATION

The panel data is analysed for the Panel unit root process by applying Im, Pesaran and Shin W-stat, ADF - Fisher and PP - Fisher Chi-square test.

$$yit = \rho yi\ t-1 + \alpha 0 + \sigma t + \sigma i + \theta t + \varepsilon it$$

where, ρ, *0, σ* are coefficients, *αi* is individual specific effect, *θt* is time specific effect. The ADF model is stated as:

$$\Delta yit = \rho iyit - 1 + \sum_{j=1}^{pi} \delta ij \Delta yi, t - j + \alpha i + \varepsilon it$$

The null hypothesis and the alternative hypotheses are expressed as:

$$H_0 : \rho_i = 0$$
$$H_A : \rho_i < 0$$

The null hypothesis of unit root test is that all series are non-stationary under the alternate hypothesis that the series in the panel are supposed to be stationary.

The Fisher Cointegration is then applied to analyse the long run cointegration among the series. The series integration is based on the significance of two statistics such that max-eigen test and trace test. The null hypothesis indicates that there is no long run cointegration among the series against the alternative hypothesis of long run cointegration.

4.3 KAO AND PEDRONI TEST

Before moving towards model, it is crucial to consider the test of co-integration to avoid spurious regression. The most appropriate technique of cointegration in the existence of cross-sectional dependence is the Kao, (1999) and Pedroni, (2001) Cointegration test. The Kao test executes homogenous cointegrating vectors and AR coefficients but doesn't incorporate for multiple explanatory variables in the cointegrating vectors. Therefore, Pedroni test is also applied that captures the within and between effects in the panels. It is built on pooling along the "within" dimension (pooling the AR coefficients across varying cross-sections of the panel for the unit root test on the residuals).

Kao and Pedroni panel cointegration test used to evaluate the null hypothesis of no cointegration against the alternative hypothesis of cointegration relationship between the variables.

The following hypothesis is evaluated under the Kao and Pedroni panel cointegration test i.e.,

H_0: ρ=1 (no cointegration)

H_1: ρ<1 (cointegration between the variables).

4.4 VECM VECTOR ERROR CORRECTION MODEL

VECM model employed for identifying short run elasticity of the relationship among renewable, non-renewable energy sources and energy import. The error correction term shows the rate of adjustment from disequilibrium to equilibrium.

To calculate short run panel causalities, VECM based model specify as follow:

$$\mathbf{EI = \beta_0 + \beta_1 CS + \beta_2 NGS + \beta_3 NS + \beta_4 HS + \beta_5 OS + \beta_6 RS + \mu_t} \quad \text{(1)}$$

The Eq.(1) shows the basic model of the study, where EI denotes energy imports, CS is coal source, NGS is natural gas source, HS is hydro source, OS is oil source, RS is renewable source and finally μ is error term.

$$\Delta EI_t = \propto_1 + \sum_{i=1}^{p} \beta_{1i} \Delta EI_{t-1} + \sum_{i=1}^{p} \beta_{1i} \Delta CS_{t-1} + \sum_{i=1}^{p} \beta_{1i} \Delta NGS_{t-1} + \sum_{i=1}^{p} \beta_{1i} \Delta NS_{t-1} + \sum_{i=1}^{p} \beta_{1i} \Delta HS_{t-1} + \sum_{i=1}^{p} \beta_{1i} \Delta OS_{t-1} + \sum_{i=1}^{p} \beta_{1i} \Delta RS_{t-1} + \mu_{1t} \quad \text{(2)}$$

$$\Delta CS_t = \propto_2 + \sum_{i=1}^{p} \beta_{2i} \Delta EI_{t-1} + \sum_{i=1}^{p} \beta_{2i} \Delta CS_{t-1} + \sum_{i=1}^{p} \beta_{2i} \Delta NGS_{t-1} + \sum_{i=1}^{p} \beta_{2i} \Delta NS_{t-1} + \sum_{i=1}^{p} \beta_{2i} \Delta HS_{t-1} + \sum_{i=1}^{p} \beta_{2i} \Delta OS_{t-1} + \sum_{i=1}^{p} \beta_{2i} \Delta RS_{t-1} + \mu_{2t} \quad \text{(3)}$$

$$\Delta NGS = \propto_3 + \sum_{i=1}^{p} \beta_{3i} \Delta EI_{t-1} + \sum_{i=1}^{p} \beta_{3i} \Delta CS_{t-1} + \sum_{i=1}^{p} \beta_{3i} \Delta NGS_{t-1} + \sum_{i=1}^{p} \beta_{3i} \Delta NS_{t-1} + \sum_{i=1}^{p} \beta_{3i} \Delta HS_{t-1} + \sum_{i=1}^{p} \beta_{3i} \Delta OS_{t-1} + \sum_{i=1}^{p} \beta_{3i} \Delta RS_{t-1} + \mu_{3t} \quad \text{(4)}$$

$$\Delta NS_t = \propto_4 + \sum_{i=1}^{p} \beta_{4i} \Delta EI_{t-1} + \sum_{i=1}^{p} \beta_{4i} \Delta CS_{t-1} + \sum_{i=1}^{p} \beta_{4i} \Delta NGS_{t-1} + \sum_{i=1}^{p} \beta_{4i} \Delta NS_{t-1} + \sum_{i=1}^{p} \beta_{4i} \Delta HS_{t-1} + \sum_{i=1}^{p} \beta_{4i} \Delta OS_{t-1} + \sum_{i=1}^{p} \beta_{4i} \Delta RS_{t-1} + \mu_{4t} \quad \text{(5)}$$

$$\Delta HS_t = \propto_5 + \sum_{i=1}^{p} \beta_{5i} \Delta EI_{t-1} + \sum_{i=1}^{p} \beta_{5i} \Delta CS_{t-1} + \sum_{i=1}^{p} \beta_{5i} \Delta NGS_{t-1} + \sum_{i=1}^{p} \beta_{5i} \Delta NS_{t-1} + \sum_{i=1}^{p} \beta_{5i} \Delta HS_{t-1} + \sum_{i=1}^{p} \beta_{5i} \Delta OS_{t-1} + \sum_{i=1}^{p} \beta_{5i} \Delta RS_{t-1} + \mu_{5t} \quad \text{(6)}$$

$$\Delta OS_t = \propto_6 + \sum_{i=1}^{p} \beta_{6i} \Delta EI_{t-1} + \sum_{i=1}^{p} \beta_{6i} \Delta CS_{t-1} + \sum_{i=1}^{p} \beta_{6i} \Delta NGS_{t-1} + \sum_{i=1}^{p} \beta_{6i} \Delta NS_{t-1} + \sum_{i=1}^{p} \beta_{6i} \Delta HS_{t-1} + \sum_{i=1}^{p} \beta_{6i} \Delta OS_{t-1} + \sum_{i=1}^{p} \beta_{6i} \Delta RS_{t-1} + \mu_{6t} \quad \text{(7)}$$

$$\Delta RS_t = \propto_7 + \sum_{i=1}^{p} \beta_{7i} \Delta EI_{t-1} + \sum_{i=1}^{p} \beta_{7i} \Delta CS_{t-1} + \sum_{i=1}^{p} \beta_{7i} \Delta NGS_{t-1} + \sum_{i=1}^{p} \beta_{7i} \Delta NS_{t-1} + \sum_{i=1}^{p} \beta_{7i} \Delta HS_{t-1} + \sum_{i=1}^{p} \beta_{7i} \Delta OS_{t-1} + \sum_{i=1}^{p} \beta_{7i} \Delta RS_{t-1} + \mu_{7t} \quad \text{(8)}$$

And finally, ETC term can be expressed as

$$ECT_{t-1} = EI_t - \beta_0 - \beta_1 CS - \beta_2 NGS - \beta_3 NS - \beta_4 HS - \beta_5 OS - \beta_6 RS \quad \text{(9)}$$

Where t=1….T, denotes the time period.

5 ESTIMATION AND INTERPRETATION OF RESULTS

This section contains the following sequential estimations i.e., descriptive statistics of the variables, correlation table, panel unit root tests, panel cointegration tests for evaluating energy import and energy sources phenomenon for BRIC countries. Table 1 shows the descriptive statistics of the variables for ready reference.

TABLE: 01 DESCRIPTIVE STATISTICS

Variables	Energy Imports	Coal Source	Hydro Source	Natural Gas	Nuclear Source	Oil Source	Renewable Source
Mean	-6.165842	41.21916	32.69064	15.00813	5.294581	3.437164	2.261572
Maximum	38.72102	82.12156	93.33336	50.62575	18.73540	11.49330	17.85239
Minimum	-89.75916	1.934310	8.195694	-0.584098	0.000000	-0.829887	0.006007
Std. Dev.	38.85171	32.06908	28.79119	18.61140	5.806340	2.340056	3.311115
Skewness	-1.087595	-0.036006	1.238511	1.033273	1.212440	0.900082	2.346885
Kurtosis	2.674456	1.142043	2.712314	2.287304	2.734862	4.306882	9.557042
Jarque-Bera	23.38090	16.70975	30.05559	23.09632	28.75997	23.91789	314.2937
Probability	0.000008	0.000235	0.000000	0.000010	0.000001	0.000006	0.000000
Observations	116	116	116	116	116	116	116

The table 01 demonstrates the descriptive statistics of all the variables. Mean is indicated the measurement of central tendency. The mean value of energy import is -6.16 that show the on average value import of energy for BRIC nations and correspondingly for other variables. Maximum extreme indicates possible outlier and data entry error up to maximum end while minimum value shows data spread to the lowest minimum end. The maximum value of energy imports 38.72 for four BRIC nations and minimum is -89.75. Standard deviation shows how data spread out about their mean. Skewness and Kurtosis shows the level to which data is unstable or not symmetrical from normal distribution. The value of skewness for energy import and coal sources are negatively skewed and rest of the variables shows that data is positively skewed. The results exhibit all the variables have positive kurtosis.

TABLE: 02 CORRELATION MATRIX

Correlation Probability	Energy Imports	Coal Source	Hydro Source	Natural Gas	Nuclear Source	Oil Source	Renewable Source
Energy Imports	1.000000						

Coal Source	0.393292	1.000000					
	0.0000	-----					
Hydro Source	0.316771	-0.695087	1.000000				
	0.0005	0.0000	-----				
Natural Gas	-0.925862	-0.456680	-0.317615	1.000000			
	0.0000	0.0000	0.0005	-----			
Nuclear Source	-0.950448	-0.439172	-0.305976	0.969458	1.000000		
	0.0000	0.0000	0.0008	0.0000	-----		
Oil Source	-0.033705	-0.153695	0.035872	0.118106	-0.049092	1.000000	
	0.7195	0.0995	0.7022	0.2067	0.6007	-----	
Renewable Source	0.396279	-0.205882	0.382378	-0.275687	-0.333206	-0.061746	1.000000
	0.0000	0.0266	0.0000	0.0027	0.0003	0.5102	-----

Correlation Matrix displays different level of correlation among predictor and predicted variables that are energy import and independent variables coal, natural gas, nuclear, hydro, oil, and renewable energy sources. Coal sources, hydro sources and renewable energy sources have positive correlation with energy imports. On the contrary natural gas, nuclear sources are strong negative and oil sources have weak negative to energy imports. Coal sources has weak negative correlation with natural gas, nuclear, oil, renewable energy sources and strong correlation to hydro sources. Hydro sources have weak positive correlation with oil and renewable energy positive sources and week negative to natural gas and nuclear energy resources. Natural gas weak negative correlation with renewable sources and strong positive and weak positive to nuclear and oil respectively. Nuclear has weak negative correlation to oil and renewable energy resources. Oil sources has also negative correlation to renewable energy sources.

TABLE: 03 PANEL UNIT ROOT

Variables	Summary Statistics				
		LLC (Prob)	IPS(Prob)	ADF(Prob)	PPF (Prob)
Energy Imports	Level	0.04933 (0.5197)	1.92628 (0.9730)	2.11397 (0.9773)	0.78128 (0.9993)
	First Difference	-3.96425 (0.0000)	-4.83037 0.0000)	38.1777 (0.0000)	71.4656 (0.0000)
Coal Source	Level	5.00706 (1.0000)	4.38045 (1.0000)	0.57754 (0.9998)	1.06785 (0.9978)
	First Difference	-0.90641 (0.1824)	-2.41818 (0.0078)	18.5562 (0.0174)	60.7108 (0.0000)
Hydro Source	Level	1.55304 (0.9398)	1.68069 (0.9536)	4.83531 (0.7750)	7.44850 (0.4891)
	First Difference	-4.81174 (0.0000)	-5.05497 (0.0000)	40.1354 (0.0000)	82.0216 (0.0000)
Natural Gas	Level	3.79117 (0.9999)	4.37052 (1.0000)	0.45280 (0.9999)	0.62987 (0.9997)
	First Difference	-2.74962 (0.0030)	-3.22668 (0.0006)	25.1265 (0.0015)	61.7065 (0.0000)
Nuclear Source	Level	-1.00358 (0.1578)	-0.41033 (0.3408)	8.40434 (0.3950)	4.76949 (0.7819)
	First Difference	-5.86612 (0.0000)	-5.28952 (0.0000)	41.7697 (0.0000)	61.8719 (0.0000)
Oil Source	Level	-2.26482 (0.0118)	0.08783 (0.5350)	10.0294 (0.2630)	7.71415 (0.4619)
	First Difference	-4.79666 (0.0000)	-5.38072 (0.0000)	42.6458 (0.0000)	78.8604 (0.0000)
Renewable Source	Level	6.68293 (1.0000)	7.92039 (1.0000)	0.01564 (1.0000)	0.00094 (1.0000)
	First Difference	-0.44830 (0.3270)	-0.89398 (0.1857)	10.9948 (0.2020)	20.5696 (0.0084)

Table 03 gives the results of ADF and PPF tests results. The unit root test shows data are often originated to be non-stationary at level for panel estimations. Therefore, first it is mandatory to check the stationarity of all variables i.e. energy import, coal, natural gas, nuclear, oil and renewable sources used in this analysis. For this study we used different test of unit root testing which are Augmented Dickey-Fuller (ADF) test and Phillip Peron.

The finding exposes that the variables are non-stationary at level but stationary at first difference. Thus, we accomplish that these variables are integrated of order one i.e. *I* (1). Furthermore, the cointegration test used for identifying the relationship between energy import and independent variables coal, natural gas, nuclear, oil, and renewable energy sources. This validates the intention that energy import and all the explanatory variables are undeniably cointegrated in the long run and association holds. In order to check stability of long run relationship, Johansen Fisher Panel Cointegration test is applied.

TABLE: 04 JOHANSEN FISHER PANEL COINTEGRATION TEST

Series: Energy Imports, Coal Source, Hydro Source, Natural Gas, Nuclear Source, Oil Source, Renewable Source					
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)					
Trend assumption	**Hypothesized No. of CE(s)**	**Fisher Stat.* (from trace test)**	**Prob.**	**Fisher Stat.* (from max-eigen test)**	**Prob.**
	None	177.3	0.0000	114.5	0.0000
	At most 1	106.4	0.0000	68.70	0.0000
	At most 2	49.54	0.0000	36.87	0.0000
	At most 3	20.17	0.0097	12.48	0.1310
	At most 4	12.02	0.1504	14.14	0.0783
Linear deterministic trend	**At most 5**	3.692	0.8838	4.473	0.8121
	At most 6	2.627	0.9555	2.627	0.9555
	None	205.1	0.0000	107.1	0.0000
	At most 1	120.9	0.0000	71.05	0.0000
	At most 2	56.59	0.0000	41.07	0.0000
	At most 3	24.74	0.0017	11.65	0.1675
	At most 4	16.33	0.0379	11.01	0.2014
Linear deterministic trend (restricted)	**At most 5**	9.383	0.3110	9.369	0.3122
	At most 6	5.012	0.7563	5.012	0.7563

The study employed Johansen Fisher Panel Cointegration test to check the cointegration relationship between the observed variables. The results confirm the presence long run co-integration among energy import, coal, natural gas, nuclear, oil, and renewable energy sources for BRIC nations as the probability value specify the significance level at 1%.

TABLE: 05 KAO RESIDUAL COINTEGRATION TEST

Null Hypothesis	No cointegration	
Trend assumption	No deterministic trend	
Statistics	**t-Statistic**	**Prob.**
ADF	-2.564940	0.0052
Residual variance	5.866415	
HAC variance	8.329393	

At Table 5 according to Kao residual cointegration test, H_0 hypothesis (no cointegration between series) would be rejected, as the probability value 0.0052 indicates significance level at 5 %. so that test statistics are significant. ADF test statistics are significance so therefore, we may accept alternative hypothesis and presence of relationship between energy import and all independent variables in the long run will be certain.

TABLE: 06 PEDRONI RESIDUAL COINTEGRATION TEST

Null Hypothesis	**No cointegration**						
Trend assumption	**No deterministic trend**			**Deterministic intercept and trend**		**No deterministic intercept or trend**	
		Statistic Prob.	**Weighted Statistic Prob.**	**Statistic Prob.**	**Weighted Statistic Prob.**	**Statistic Prob.**	**Weighted Statistic Prob.**
Alternative hypothesis: common AR coefs. (within-dimension)	**Panel v-Statistic**	0.294236 0.3843	0.234821 0.4072	1.200179 0.1150	1.382462 0.0834	-0.467538 0.6799	-0.240913 0.5952
	Panel rho-Statistic	0.629150 0.7354	0.889198 0.8131	1.181374 0.8813	1.603452 0.9456	0.585757 0.7210	0.696314 0.7569
	Panel PP-Statistic	-1.969651 0.0244	-1.899504 0.0287	-3.965016 0.0000	-3.410922 0.0003	-1.048795 0.1471	-1.303001 0.0963
	Panel ADF-Statistic	-2.079513 0.0188	-2.494574 0.0063	-3.855186 0.0001	-4.447212 0.0000	-1.134900 0.1282	-1.980353 0.0238
Alternative hypothesis: individual AR coefs. (between-dimension)	**Group rho-Statistic (Prob.)**	1.396213 0.9187		2.149862 0.9842		1.729271 0.9581	
	Group PP-Statistic (Prob.)	-2.818298 0.0024		-3.357451 0.0004		-0.820681 0.2059	
	Group ADF-Statistic (Prob.)	-3.443803 0.0003		-4.398357 0.0000		-2.066531 0.0194	

Table 06 Pedroni cointegration test is applied as primary differences of variables are found to be stationary. The results of tests indicate the rejection of null hypothesis (H_0) (no cointegration between series) as the probability values are less than 1,5 and 10%. So here we accept H_1. The results of all other tests are statistically meaningful apart from Group Rho-Statistic test. According to the results of these test, there is a relationship between energy import and conventional and renewable energy resources in the long run period.

TABLE: 07 VECM VECTOR ERROR CORRECTION MODEL

Variables	Coefficient	St. Error	t-value
ECT_{t-1}	-0.0346	0.0105	-3.3028
Coal Source	0.3200	0.0351	9.1229
Hydro Source	0.0362	0.0096	3.7516
Natural gas	0.1983	0.0483	4.1096
Nuclear Source	-0.5729	0.0707	-8.1033
Oil Source	-0.0567	0.0255	-2.2239
Renewable Source	-3.0777	0.5910	-5.2080
Constant	1.1548	0.4250	2.7169
R-Square	0.534	**F-Statistics**	3.7819
Adjusted R-Square	0.521	**Prob.(F-Statistics)**	0.027

VECM shows short run causality running from energy imports to all independent variables. The econometric result shows that in short run one percent increase in electricity production from coal increases energy import by 0.3200 percent. This result shows that the coal is not economically feasible source of electricity generation in BRIC nations. Moreover, the reason behind increment in energy import is the availability of substandard coal so that this is not efficient way of electricity generation.

Further the empirical result shows that one percent increase in Electricity production from natural gas increases the energy import by 0.1983 percent in short run. Thus, indicating that there is a positive relation between energy import and electricity production from natural gas.

Energy generation from oil sources is also significant as their results indicate that one % increase in energy production from oil leads to decrease -0.0567% energy import. It means that electricity production from oil sources are also economically feasible, reliable, and cost competitive. Moreover, huge energy demand can be fulfilled by oil sources for future consumption.

Moving towards nuclear source empirical result shows that one percent increase in Electricity production from nuclear source decreases the energy import by -0.5729 percent. Thus, indicates that there is a negative relation between Energy import and power production from nuclear source. It means that in short run huge investment, efficient technology, maintenance cost, and proliferation process is requiring in electricity generation from nuclear sources. Furthermore, the wastes generated in process of electricity generated are less radioactive.

Finally, the empirical estimation shows that one percent increase in Electricity production from Renewable source decreases the energy import by -3.0777 percent in short run. Thus, indicating that there is an inverse/negative relation between energy import and electricity (power) production from Renewable source.

It shows that renewable source as energy is environment friendly, cheap, cost effective, potential source of meeting future energy demands in easy and simple way. The studies also depict that renewable energy source is more important in revenue generation and job creation incorporation in the long run growth and development which directly and indirectly reduces energy import bill.

The F- stats probability value 0.027 shows best fit model such that the value is significant at 5 % and there is no issue of autocorrelation. The value of R square 0.534 indicates 53 % variations in energy import due to observed independent variables.

TABLE: 08 WALD TEST

Wald Test:			
System: %system			
Test Statistic	**Value**	**df**	**Probability**
Chi-square	2.914344	3	0.04050
Null Hypothesis: c(2)=c(3)=c(4)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		**Value**	**Std. Err.**
C(2)		0.164937	0.105660
C(3)		0.038864	0.100330
C(4)		0.320031	1.050075
Restrictions are linear in coefficients.			

The results reject the null hypothesis of no long run causality. Hence, the Chi-square statistics of the Wald test with 5 percent significance level indicates that there exist long run causality moving from convention and renewable energy sources to energy import.

6. CONCLUSION AND RECOMMENDATIONS:

The prevailing energy crisis are the results of a lack of planning, imperfect policies, and poor decision-making. The issue cannot be sort out without the strong obligation of the nations and steps taken in the right direction. This study has presented a comprehensive overview of the energy industry of BRIC nations and provides recommendation to decision-makers that to use energy technology and resource development for lowering and overcoming the energy crisis.

The energy import and power generation from renewable energy sources have become important challenges facing many countries. These growing concerns have brought the importance of both energy import and renewable energy to the forefront of the broader energy usage debate. Renewable energy can play an important role not only in energy security, but also in reducing emissions. The objective of this paper is to empirically examine a statistical relationship between the energy import and electricity generated by conventional and renewable energy sources. The study uses annual data from time period of 1990-2018 for BRIC nations. By employing Johansen Fisher Cointegration technique the empirical results support that Renewable Energy Sources has significant long run casual effect. Furthermore, the result reveals that one percent increases in generation of electricity from nuclear source, oil source and renewable sources decreases energy import by -0.572, -0.0567 and -3.0777 percent respectively. On the other hand, one percent increases in electricity production from coal sources, hydro sources and natural gas increases energy import by 0.3200, 0.0362, and 0.1983 percent respectively in short run. It implies that in case of BRIC nation's nuclear sources and renewable energy source is an efficient option to explore and invest for the power generation and lowering energy debt burden. Improvements should sustain in order to convert the conventional power station project to new combustion technologies that are being established. These technologies allowed more electricity to be generated from fewer, but quality coal acknowledged as improving the thermal efficiency of the power ranks. Efficiency gains in power generation from coal-fired power stations will play a crucial part in reducing energy debt.

The production level of energy from renewable sources also significantly reduce pollutant emission as lifecycle emissions of natural gas production are 15 times greater than nuclear. Moreover, Lifecycle emissions of coal generation are 30 times greater than nuclear (Edwards, 1997).

Whereas, electricity generation from nuclear power plants and renewable sources (geothermal, solar, tides, wind, biomass, and biofuels) are play immense role in incorporating the energy demand and reduce energy import level. Therefore, BRIC nations should assess those technologies which have great positive influence on renewable energy investment. The renewable sources like wind and biomass have lower costs and more competitive than conventional fuels. Summing up, the findings suggests that policy makers should really focus on the implementation of advance technologies for power generation by renewable sources induced technological and conventional energy substitution in order to get rid of energy burden.

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