Energy Economics Letters
ISSN(e): 2308-2925
DOI: 10.18488/journal.82.2020.71.36.45
Vol. 7, No. 1, 36-45.

URL: www.aessweb.com

A RE-EXAMINATION OF THE RELATIONSHIP BETWEEN ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH IN INDIA

Kamaljit Singh[1+]
Simmi Vashishtha[2]

[1]*Research scholar, University School of Management, Kurukshetra University Kurukshetra, Haryana, India.*
Email: kamaljitsehjanusm17@kuk.ac.in Tel: +919812729755
[2]*Assistant Professor, University School of Management, Kurukshetra University Kurukshetra, Haryana, India.*
Email: simmiarora@kuk.ac.in Tel: +917988323986


(+ Corresponding author)

Article History
Received: 14 April 2020
Revised: 20 May 2020
Accepted: 23 June 2020
Published: 20 July 2020

Keywords
Electricity consumption
Energy conservation
GDP
VAR
Granger causality test.

JEL Classification:
C32; E21; O11 & Q43.

ABSTRACT

The intent of the study is to re-examine the relationship between per capita electricity consumption and per capita Gross Domestic Product (GDP) from 1971 to 2014. By employing the Granger causality test, the study found that there was absence of a long-term equilibrium relationship between per capita electricity consumption and per capita GDP in India, but the existence of unidirectional causality running from per capita GDP to per capita electricity consumption was reported in a Vector Autoregression (VAR) framework. The results indicate that the policymakers should encourage energy conservation measures on both the supply and demand-side which will lead to sustainable energy supply in the country. This will lead to a sustainable energy supply in the country. Moreover, if the government in collaboration with the power utility industries frames the appropriate national policy on energy conservation for entering the practical action, it will enhance economic development on a sustainable basis.

Contribution/ Originality: This research poses many questions in need of further studies viz. studies regarding creating & spreading awareness among electricity users, studies focusing on challenges & role of electricity utilities & Government in drafting policies of energy conservation and undoubtedly, it will strengthen and contribute to the existing scientific literature.

1. INTRODUCTION

India is one of the fastest-growing nations in Asia. Energy consumption is among the key inputs to achieve such development. While India's economic development experience is admired across the world, the growth in power consumption led to import dependence (Bhaskar, 2013). The energy imports are largely in the form of crude oil and oil produces. India became the world's fifth-largest economy by overtaking U.K. and France with a nominal GDP (Gross Domestic Product) of $2.94 trillion and stood at the third position in electricity consumption. However, India's per capita consumption of energy was just 1,181 kWh (kilowatt/hour) in 2018-19 which continues to be lower than many developed countries (Singh & Vashishtha, 2020). The per capita energy consumption is likely to grow with economic growth in India, thereby increasing the demand for energy.

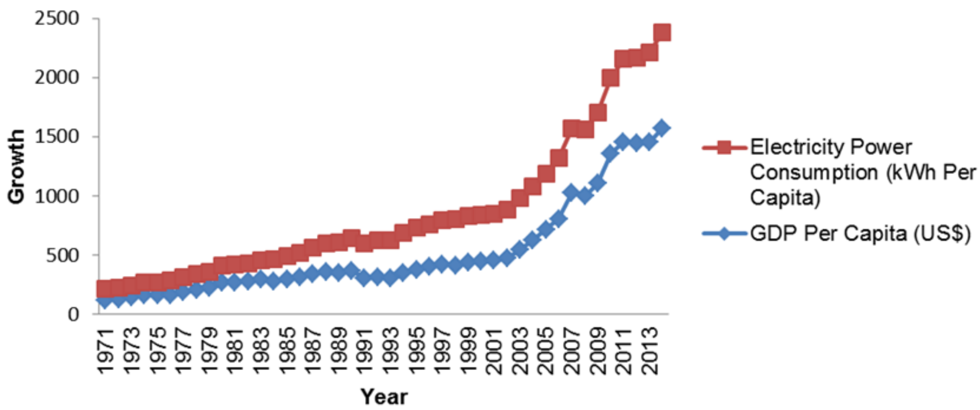

Figure-1. Electricity consumption and GDP growth.

Figure 1 reveals that both per capita electricity consumption and per capita GDP have increased, but per capita, electricity consumption has proportionately increased at a higher rate than per capita GDP during the 1971-2014 period. Annual consumption of electricity by industry accounts for more than two-fifths of India's annual electricity consumption, as indicated by government data, while residential consumption representing about a quarter and for commercial establishments another 8.5 percent Singh and Vashishtha (2019a). Growth in India's energy consumption and power supply was at a five-year low and electricity consumption can be viewed as a significant indicator of industrial output, which simultaneously influences the economic growth of the country.

1.1. Overview of Indian Power Sector

Power is an important infrastructure for economic growth and for elaborating on the quality of life. The Ministry of Power, 2013 has placed power in the list of concurrent subjects under the constitution of India with the center and state. After the independence of India, the state electricity boards were the sole utilities responsible for generation, transmission & distribution of electricity (Singh, 2020). To strengthen the efforts of the state in bridging the yawning gap between demand and supply of power, it was decided in mid-seventies to setup generation stations and associated high voltage transmission lines at the center level (Singh & Kaur, 2020). India launched its energy sector reforms in 1992 with a thrust on power sector reforms. Over the period of time, the limit of power plants has increased from a pitfall 1,713 Megawatts (MW) in 1950 to 3,57,875 MW as on 30.09.2019 and similarly, power generation increased from about 5.1 Billion Units (BU) to 1,249.3 BU in the year 2018-19 (Singh & Vashishtha, 2019b). As delineated in Figure 2 the maximum energy-intensive sector is the industrial sector accounting for 41 percent of total energy consumption in the year 2018-19.

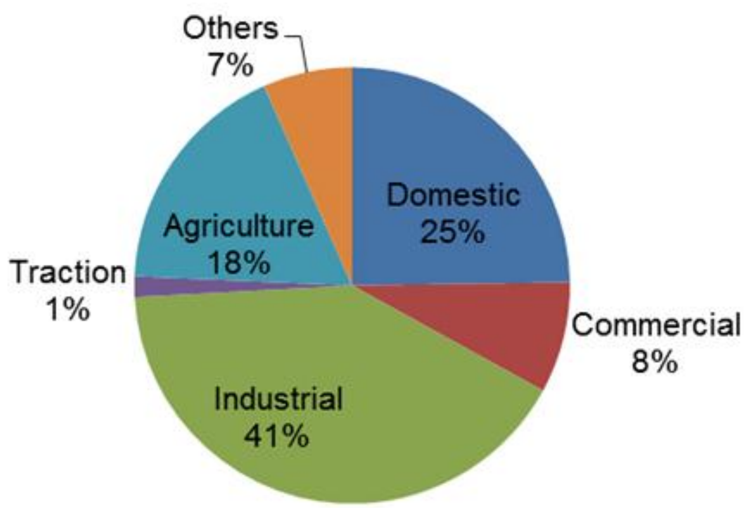

Figure-2. Category wise electricity consumption.

The availability of required power is a parameter of economic growth and economic growth leads to growth in demand for power. Although there has been an immense consensus that power is the software of economic growth, the causal relationship and a precise economic link between per capita energy consumption and economic growth at an individual country level have been scant (Bhaskar, 2013). This relationship has gained significant importance, as it is mandatory to know the same to frame relevant policies at the aggregate level. Further, studies on causal relationships between the electricity consumption and economic growth for long-period data of India are limited. The growth, conservative, feedback, and neutrality are the four major hypotheses to know the direction of a causal relationship between economic growth and energy consumption. The growth hypothesis exists when electricity consumption affects economic growth (Unidirectional) and the conservative hypothesis is vice versa. When both electricity consumption and economic growth affect each other then there is a feedback hypothesis (Bidirectional) but if both are independent it becomes neutrality hypothesis (Independent) (Singh & Mann, 2020). In the view of the importance of energy consumption and economic growth, the aim of the present study is to examine whether the direction of the relationship between per capita electricity consumption and per capita GDP is unidirectional, bidirectional or independent, which is so far lacking in the available scientific literature.

The section reveals the core problem of study. In the following section, an examination of the literature review done by researchers in Indian & other Asian countries context has been presented. The third and fourth section discusses the research methodology and results & interpretation, respectively. The last section concludes and based on results; some enumerable policy implications have been proposed.

2. LITERATURE REVIEW

There is a considerable amount of literature available on the relationship between electricity consumption and per capita GDP. The seminal work Kraft and Kraft (1978) on the relationship between energy and GNP in the United States for the period of 1947-1974, arouses curiosity and led the researchers to research on economies of different nations across the world. In this section, a review of the studies has been presented in respect of India and other Asian countries.

Aqeel and Butt (2001) investigated a causal relationship between energy consumption and economic growth in Pakistan for the period of 1955-1996, used co integration and Hsio version of Granger Causality Test and concluded that economic growth affects electricity consumption. In the cutting edge paper Ghosh (2002) on the relationship between electricity consumption and economic growth in India for the period of 1951-1997, applied Vector Autoregression (VAR) & Granger Causality Test and reported a unidirectional relationship revealing that economic growth affects electricity consumption. In China Shiu and Lam (2004) analyzed the relationship between electricity consumption and economic growth for the period of 1971-2000 through the Error Correction Model (ECM) and concluded a unidirectional relationship revealing that electricity consumption affects economic growth.

In Turkey Altinay and Karagol (2005) studied causal relationships through the VAR & standard Granger Causality Test for the period of 1950-2000 and pointed out the unidirectional relationship effect of energy consumption on income. Yoo (2005) examined the direction of a causal relationship between electricity consumption and economic growth in Korea for a data period of 1970-2002 and concluded a bidirectional relationship between electricity consumption and economic growth. In Indonesia Yoo and Kim (2006) found a unidirectional causal relationship, reporting that economic growth affects electricity consumption for the period of 1971-2002 through cointegration and standard Granger Causality Test. In Bangladesh Mozumder and Marathe (2007) analyzed the causal relation with Vector Error Correction Model (ECM) & Granger Causality Test and reported no causality between per capita electricity consumption and per capita Gross Domestic Product (GDP).

Similarly, Chen, Kuo, and Chen (2007) analyzed electricity consumption and economic growth relationship of ten Asian countries, by applying standard Granger Causality Test on the data for the period of 1971-2001 and traced out no causality between electricity consumption and economic growth in India. In Malaysia Tang (2008) by applying the cointegration and Error Correction Model (ECM) found no causality in electricity consumption and economic growth for the period of 1960-1998. In Nepal Dhungel (2009) and Mallick (2009) in India analyzed the causal relationship of electricity consumption and economic growth through Vector Autoregression (VAR) & Granger Causality Test on the different period's datasets and both studies concluded a unidirectional relationship i.e. economic growth affects electricity consumption in respective countries. In Lebanon Abosedra, Dah, and Ghosh (2009) found a unidirectional relationship by applying Vector Autoregression (VAR) on the short period data 1995-2005 and concluded that electricity consumption affects economic growth Gupta and Sahu (2009) in their seminal work in India for the period of 1960-2008 through the Granger Causality Test concluded there was a unidirectional relationship i.e. electricity consumption affects economic growth.

In Russia Zhang (2011) also evaluated the causal relationship on the data period of 1990-2008, applied standard Granger Causality Test and found no causality in electricity consumption and economic growth. In more recent studies Shahbaz and Lean (2012) in Pakistan run causal relationship tests through the Vector Error Correction Model (VECM) & Granger Causality test for the period of 1972- 2000 and found bidirectional relationship in economic growth and electricity consumption. Behera (2015) applied Vector Autoregression on Indian data, Tang, Tan, and Ozturk (2016) applied co-integration on Vietnam data for the period of 1970-2011, and similarly, Tursoy and Resatoglu (2016) applied VAR & Granger Causality Test in Russia for the period of 1990-2011 Behera (2015) and Tursoy and Resatoglu (2016) found same results of bidirectionality, which concluded both electricity consumption & economic growth affects each other in respective countries whereas Tang et al. (2016) pointed out unidirectional relationship showing that electricity consumption affects economic growth.

Although there has been ample literature available, however, we focus on studies that specifically identified the causal relationship between electricity consumption and economic growth. From the above discussed empirical work, we can draw a conclusion that the research outcomes have been dissimilar across the countries and even in the same country. It could be because of the different methodologies, time or source of data. So, the study attempts to re-examine the relationship between per capita electricity consumption and per capita GDP in India's perspective.

3. METHODOLOGY

3.1. Data

The study employs time-series data from 1971 to 2014 to define the relationship direction between electricity consumption and Gross Domestic Product. The data of per capita electricity consumption and per capita GDP has been retrieved from www.data.worldbank.org and information about the Indian Power Sector and sector-wise energy has been from the Central Electricity Authority (CEA) and Energy Statistics, 2019. The statistical application EViews (IHS Global Inc., USA) has been employed to test the existence and direction of causality.

3.2. Unit-Root Test (Augmented Dickey–Fuller)

The first step tests for the order of integration of the log variables using Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1981) statistics. Before analyzing the time series estimation, unit root testing procedures (stationarity) has been performed.

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-1} + E_t$$

3.2. Johansen Co-Integration

The second step carries out examining the cointegration relationship between the variables. Johansen (1988) test and estimation strategy, maximum likelihood makes it possible to estimate two or more than two variables. The Johansen tests are known as the trace test and the maximum eigenvalue test.

3.2.1. Trace Test

The trace test helps in knowing whether the matrix rank (π) is r_0. The likelihood ratio test statistic is

$$LR\,(r_0, n) = -T \sum_{i=r_{0+1}}^{n} In\ (1 - \lambda_i)$$

According to Johansen (1995) the trace of a matrix is based on functions of Brownian Motion or Standard Wiener Processes i.e. the test statistic's asymptotic distribution.

3.3.2. Maximum Eigen Value Test

The maximum Eigen value test has performed to know whether the largest Eigen value is zero or not. Although, it helps in knowing the alternative that the next largest Eigen value is zero.

$$LR\,(r_0 + r_0 + 1) = -T\, In\,(1 - \lambda r_0 + 1)$$

Where $LR\,(r_0 + r_0 + 1)$is the likelihood ratio test statistic for testing the rank (π)= r_0 versus the alternative hypothesis that rank (π) =$r_0 + 1$.

3.3. Vector Autoresression (VAR)

Johansen (1991) suggested that the Vector Autoregression approach is employed when no cointegration exists between two series. As a basic function of the lagged values of endogenous variables in the system, the VAR approach sidesteps the requirement for structural modeling by modeling each endogenous variable in the system. The mathematical form of a VAR is

$$z_t = \binom{x_t}{y_t} = \beta + \beta_1 t + \sum_{i=1}^{k+1} A_t\ z_{t-1} + u_t$$

$$\mathbf{A_t} = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix}$$

3.4. Granger Causality Test

The Granger causality test validates the direction of causality flow from one to the other variables and vice versa. Moreover, the information contained in one variable correctly predicting another variable. As suggested by Granger (1969) causality test regress y variable on a lagged value of itself and another x variable. The model of the Granger causality test is as follows:

$$\Delta Y_t = \alpha + \sum_{i=1}^{k} \beta_i \Delta Y_{t-i} + \sum_{i=1}^{k} \gamma_i \Delta X_{t-i} + \mu$$

$$\Delta X_t = \alpha + \sum_{i=1}^{k} \beta_i \Delta X_{t-i} + \sum_{i=1}^{k} \psi_i \Delta Y_{t-i} + \mu$$

Where Y_t and X_t are defined as Y and X observation over t time periods; Δ is the difference operator; k represents the number of lags; α, β, ψ, and γ are parameters to be estimated; μ represents the serially uncorrelated error terms.

4. RESULTS & INTERPRETATIONS

4.1. Unit-Root Test

Table 1 test the assumption of constant & linear trend test at the level & the first difference under the coefficient of the Augmented Dickey-Fuller (ADF) is reported. The time series should be stationary to run further tests. The ADF test shows in the level form that the null hypothesis H_0: Y_t is not I (0) and rejected for the series Per Capita Gross Domestic Product (PCGDP) and Per Capita Electricity Consumption (PCEC) at 1, 5 and 10 percent level of significance.

Table-1. Unit-root test (augmented dickey-fuller).

Variables at Level	ADF Test (P-Values) *	First Difference (P-Values) *
LPCGDP	0.9270	.0000
LPCEC	0.3710	.0001

Note: *indicates significant at the 1 percent level, LPCGDP- Log Per Capita Gross Domestic Product, LPCE-Log Per Capita Electricity Consumption.

The results demonstrate that the time series data of PCGDP and PCEC was stationary. However, both series became stationary in the first difference, and the ADF test for the first difference supports both the series Per Capita Gross Domestic Product and Per Capita Electricity Consumption of order I (1). To choose the lag length Akaike's Information Criterion (AIC) and Schwarz Information Criterion (SIC) were taken into consideration. The Akaike's Information Criterion (AIC) criterion in Table 2 was used to determine the lag length in an AR (P) model and the lowest value of AIC is preferred while comparing two or more models.

Table-2. Result of lag length criteria.

Lag	AIC	SIC
0	1.65	1.74
(1)	**-6.722749***	**-6.469417***
2	-6.54	-6.11
3	-6.39	-5.80
4	-6.25	-5.49

Note: *Indicates lag order, AIC- Akaike's Information Criterion, SIC- Schwarz Information Criterion.

To forecast the performance of a model the Akaike's Information Criterion (AIC) and Schwarz Information Criterion (SIC) were used to compare in-sample and out-of-sample. The lowest value of AIC and SIC in total lag length criteria was -6.722749 and -6.469417 which rejects the null hypothesis at 1, 5, and 10 percent significance level.

4.2. Johansen Co-Integration

Johansen cointegration test help in knowing about the cointegration between two or more stochastic time series. The trace test tests whether the rank of the matrix (π) is r_0 and the maximum Eigen value test examines whether the largest Eigen value is zero relative to the alternative next largest Eigen value. For both test statistics, the initial Johansen test is a test of the null hypothesis of no cointegration against the alternative of cointegration.

Table-3. Unrestricted co-integration rank test (trace and eigen value).

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0. Critical Value	Prob.**
None	0.126167	5.698213	15.49471	0.730845
At most 1	0.000806	0.033855	3.841466	0.853971

Note: -* denotes rejection of the hypothesis at the 0.05 level, **MacKinnon, Haug, and Michelis (1999) p-values.

The results of the unrestricted co-integration rank test demonstrated in Table 3 and both the Trace test & Eigen value test indicates no cointegration exists between log per capita Gross Domestic Product and log per capita electricity consumption at the 0.05 level, that is to say, acceptance of the null hypothesis. As per the rule, we reject the null hypothesis if the probability value is less than or equal to 0.05 but the MacKinnon's p-values in both (Trace & Eigen value) tests higher than 0.05 i.e. 0.730845 and 0.853971 and both the Trace & Eigen value test statistics (0.126167 and 5.698213) are also lower than the critical value (15.49471), so in both cases, we cannot reject the null hypothesis.

4.3. Vector Autoregression (VAR)

The Vector Autoregression (VAR) is generally used for estimating systems of inter-related time series and evaluating the productive impact of random disruptions on the system of variables. Table 3 Unrestricted Cointegration Rank Test (Trace and Eigen value) indicates no cointegration exists between time-series log per capita Gross Domestic Product and log per capita electricity consumption so, we estimate only the short-run model, which is Vector Auto-regression in Table 4. The information criteria are given in Table 2 such as Akaike's Information.

Table-4. Vector auto-regression estimates.

Variable	LEPC	LGDP
LEPC (-1)	0.9472*	0.0173
	(0.0186)	(0.0622)
	[51.0487]	[0.27758]
LGDP (-1)	0.0508	0.9894
	(0.0169)	(0.0567)
	[3.00177]	[17.4377]
C**	0.0424	0.0266
	(0.034)	(0.114)
	[1.24722]	[0.23315]

Note: * Coefficient of variable, **Constant of regression model, Standard errors in (), t-statistics in [].

Criterion (AIC) & Schwarz Information Criterion (SIC) were used for model selection in choosing the lag length of the Vector Auto-regression, the lowest the value of the information criteria (-6.722749 and -6.469417), the best the model. Just to like the rule of thumb, we can say if the value of t- statistics is more than 1.96 (at 95 percent confidence level) it is having a significant impact on variables and vice- versa. As the results are shown in Table 4 except the t- statistics of LGDP [0.27758] in the LEPC (-1) lag and the lags of Constant of the regression model of LEPC [1.24722] & LGDP [0.23315] all other lags shows a significant impact on variables. One thing here is very important to note that such kind of significance and not significant values do not give robust results whether a series leads to others or not, for that purpose we run Granger Causality Test.

4.4. Granger Causality Test

The test is based on the hypotheses $H_0: y_i = \psi_i = 0 \; for \; all \; i's \;\; H_1: y_i \neq 0 \; and \; \psi_i \neq 0 \; for \; at \; least \; some \; i's.$ If the values of the Y_i coefficient was statistically significant, but those of ψ_i were not, then X causes Y$(X \rightarrow Y)$. On the other hand, if the values of the ψ_i coefficients were statistically significant but those of the y_i coefficients were not, then Y causes X$(Y \rightarrow X)$. Moreover, if both ψ_i and y_i were significant then there exists bidirectional causality between X and Y$(X \leftrightarrow Y)$.

Table-5. Pairwise granger causality tests.

Null Hypothesis:	Observation	F-Statistic	Prob.
LPCGDP does not Granger Cause LPCEC	43	9.01065	0.00460*
LPCEC does not Granger Cause LPCGDP	43	0.077052	0.78276

Note: *indicates the rejection of null hypotheses at the 5 percent significant level, LPCGDP- Log Per Capita Gross Domestic Product, LPCE-Log Per Capita Electricity Consumption).

The results of the pairwise granger causality test in Table 5 suggest that the Granger causality is found to run from per capita Gross Domestic Product to per capita electricity consumption. The null hypothesis of "LPCEC does not Granger Cause LPCGDP" was rejected at the 1 percent level of significance, the value of y_i is 0.077052 with probability 0.78276. The null hypothesis "LPCGDP does not Granger Cause LPCEC" was accepted, the value of ψ_i is 9.01065 with 0.00460 probability value. This indicates that LPCGDP does not Granger Cause LPCEC because the value of the test statistic is not significant at the 1 percent level. Both results were computed using one lag period based on AIC and SIC. Our results would seem to indicate that, there exists a short-term relationship and the conservative hypothesis proved the per capita Gross Domestic Product affects per capita electricity consumption (Unidirectional). The values of the ψ_i coefficients were statistically significant and those of the y_i coefficients were not, so Y causes X$(Y \rightarrow X)$.

5. CONCLUSION AND POLICY IMPLICATIONS

Interestingly, these results suggest the conservative hypothesis which implies that the per capita GDP affects per capita electricity consumption. The shreds of evidence intimate that there are unidirectional causal relationships that highlight the importance of strengthening the policies of energy conservation appropriately, which will contribute to sustainable economic growth. On the basis of results, it is suggested that policymakers should encourage energy efficiency & conservation measures on both the supply and demand-side. This will lead to a sustainable energy supply in the country. Moreover, if the government in collaboration with the power utility industries frames the appropriate national policy on energy conservation for entering the practical action, it will enhance economic development on a sustainable basis. The enactment of enabling legislation will provide the central and state governments statutory powers for encouraging and implementing an administration of energy conservation. This research poses many questions in need of further studies viz. studies regarding creating & spreading awareness among electricity users, studies focusing on challenges & role of electricity utilities & Government in drafting policies of energy conservation and undoubtedly, it will strengthen and contribute to the existing scientific literature.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Acknowledgement: Both authors contributed equally to the conception and design of the study.

REFERENCES

Abosedra, S., Dah, A., & Ghosh, S. (2009). Electricity consumption and economic growth, the case of Lebanon. *Applied Energy, 86*(4), 429-432.Available at: https://doi.org/10.1016/j.apenergy.2008.06.011.

Altinay, G., & Karagol, E. (2005). Electricity consumption and economic growth: Evidence from Turkey. *Energy Economics, 27*(6), 849-856.Available at: https://doi.org/10.1016/j.eneco.2005.07.002.

Aqeel, A., & Butt, M. S. (2001). The relationship between energy consumption and economic growth in Pakistan. *Asia-Pacific Development Journal, 8*(2), 101-110.

Behera, J. (2015). Energy consumption and economic growth in India: A reconciliation of disaggregate analysis. *Energy, 5*(6), 15-27.

Bhaskar, B. (2013). Energy security and economic development in India: A holistic approach (pp. 1-376). India: The Energy and Resources Institute (TERI).

Chen, S.-T., Kuo, H.-I., & Chen, C.-C. (2007). The relationship between GDP and electricity consumption in 10 Asian countries. *Energy Policy, 35*(4), 2611-2621.Available at: https://doi.org/10.1016/j.enpol.2006.10.001.

Dhungel, K. R. (2009). Does economic growth in Nepal cause electricity consumption. *Hydro Nepal: Journal of Water, Energy and Environment, 5*, 37-41.Available at: https://doi.org/10.3126/hn.v5i0.2485.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica, 49*(4), 1057-1072.Available at: https://doi.org/10.2307/1912517.

Ghosh, S. (2002). Electricity consumption and economic growth in India. *Energy Policy, 30*(2), 125-129.Available at: https://doi.org/10.1016/s0301-4215(01)00078-7.

Granger, C. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica, 37*(3), 424-438.

Gupta, G., & Sahu, N. C. (2009). Causality between electricity consumption & economic growth: Empirical evidence from India (pp. 1-18). Germany: University Library of Munich.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control, 12*(2-3), 231-254.Available at: https://doi.org/10.1016/0165-1889(88)90041-3.

Johansen, S. (1995). A statistical analysis of cointegration for I (2) variables. *Econometric Theory, 11*(1), 25-59.

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica: Journal of the Econometric Society, 59*(6), 1551-1580.Available at: https://doi.org/10.2307/2938278.

Kraft, J., & Kraft, A. (1978). On the relationship between energy and GNP. *The Journal of Energy and Development, 3*(2), 401-403.

MacKinnon, J. G., Haug, A. A., & Michelis, L. (1999). Numerical distribution functions of likelihood ratio tests for cointegration. *Journal of Applied Econometrics, 14*(5), 563- 577.Available at: https://doi.org/10.1002/(sici)1099-1255(199909/10)14:5%3C563::aid-jae530%3E3.0.co;2-r.

Mallick, H. (2009). Examining the linkage between energy consumption and economic growth in India. *The Journal of Developing Areas, 43*(1), 249-280.Available at: https://doi.org/10.1353/jda.0.0038.

Mozumder, P., & Marathe, A. (2007). Causality relationship between electricity consumption and GDP in Bangladesh. *Energy Policy, 35*(1), 395-402.Available at: https://doi.org/10.1016/j.enpol.2005.11.033.

Shahbaz, M., & Lean, H. H. (2012). The dynamics of electricity consumption and economic growth: A revisit study of their causality in Pakistan. *Energy, 39*(1), 146-153.Available at: https://doi.org/10.1016/j.energy.2012.01.048.

Shiu, A., & Lam, P.-L. (2004). Electricity consumption and economic growth in China. *Energy Policy, 32*(1), 47-54.Available at: https://doi.org/10.1016/s0301-4215(02)00250-1.

Singh, K. (2020). Credit ratings of power distribution utilities in northern region of India. *Asian Journal of Economics, Finance and Management, 2*(2), 11-19.

Singh, K., & Kaur, J. (2020). A study on contemporary issues and challenges of power sector in Haryana. *International Journal of Business Education and Management Studies (IJBEMS), 5*(2), 126-129.

Singh, K., & Mann, V. (2020). A discussion on rural development strategies of Haryana. *Asian Journal of Sociological Research*, 1-4.

Singh, K., & Vashishtha, S. (2019a). Empowering the power sector through uday: A study of Haryana. *ZENITH International Journal of Multidisciplinary Research, 9*(5), 1-7.

Singh, K., & Vashishtha, S. (2019b). Performance analysis and initiative policies: A study of Indian power sector. *American Journal of Economics and Business Management, 2*(4), 163-179.

Singh, K., & Vashishtha, S. (2020). A performance analysis of power distribution utilities of Haryana. *Asian Basic and Applied Research Journal, 2*(1), 13-19.

Tang, C. F. (2008). A re-examination of the relationship between electricity consumption and economic growth in Malaysia. *Energy Policy, 36*(8), 3077-3085.Available at: https://doi.org/10.1016/j.enpol.2008.04.026.

Tang, C. F., Tan, B. W., & Ozturk, I. (2016). Energy consumption and economic growth in Vietnam. *Renewable and Sustainable Energy Reviews, 54*, 1506-1514.Available at: https://doi.org/10.1016/j.rser.2015.10.083.

Tursoy, T., & Resatoglu, N. G. (2016). Energy consumption, electricity, and GDP causality; the case of Russia, 1990-2011. *Procedia Economics and Finance, 39*, 653-659.Available at: https://doi.org/10.1016/s2212-5671(16)30312-4.

Yoo, S.-H. (2005). Electricity consumption and economic growth: Evidence from Korea. *Energy Policy, 33*(12), 1627-1632.Available at: https://doi.org/10.1016/j.enpol.2004.02.002.

Yoo, S.-H., & Kim, Y. (2006). Electricity generation and economic growth in Indonesia. *Energy, 31*(14), 2890-2899.Available at: https://doi.org/10.1016/j.energy.2005.11.018.

Zhang, Y.-J. (2011). Interpreting the dynamic nexus between energy consumption and economic growth: Empirical evidence from Russia. *Energy Policy, 39*(5), 2265-2272.Available at: https://doi.org/10.1016/j.enpol.2011.01.024.