



THE LINKAGE BETWEEN ECONOMIC GROWTH AND ENERGY CONSUMPTION: EVIDENCE FROM ASIAN ECONOMIES

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Abstract

Energy provides many benefits along with a multitude of economic growth and development. However, billions are still relying on traditional fuels causing pollution and health issues. The study analyzes the linkage between energy consumption and economic growth based on per capita GDP for 8 major economies of Asia based on their size of GDP. Through the method of ANOVA, correlation, and time series analysis it has been seen that there is an increase in energy consumption along with the increase in the per capita GDP of an economy. The goodness of fit relation also concludes a direct and positive relationship between the consumption of energy and per capita GDP.

Keywords: Energy, consumption, GDP, linkage, analysis.

INTRODUCTION

A developing country is bounded by its limitations and characteristics to attain economic growth and development. Every developing country focuses its strategy in a way to have increased productivity, efficiency, job creation, increase in income, better standard of living, etc. considering all socioeconomic aspects of an individual and economy. This makes it evident for an economy to invest in a sector that is more oriented towards the development of the economy. Considering these aspects, the paper is directed to study the importance and role of energy and electricity in the development of an economy, its demand, and its relation to its GDP.

Under this context, the World Bank is taking measures and helping countries to provide their population with affordable and sustainable energy access with a vision to eradicate poverty and promote prosperity. In this regard, World Bank has provided a fund of over \$5 billion for 70 projects since, 2010. Energy and electricity provide many benefits along with a multitude of economic growth and development. About billions of people still in the world do not have access to electricity due to which they are relying on traditional fuels causing pollution and health issues. Studies show that access to energy has transformed lives in different ways such as- an increase in income, increase in productivity, cleaner water and environment, etc. energy has an important role in the socioeconomic development of the economy. In this aspect, the economic growth of developing nations has

witnessed an accelerated increase in energy consumption. So, the study of the consumption of energy and electricity will be helpful to predict the future expected need from these sources through the study of past and present consumption (Alam et al., 2025).

Electricity and energy are an essential part of living and is recognized as basic human need. It provides an infrastructure to an economy for its socio-economic development, poverty alleviation, prosperity and increase in the standard of living.

Review of Literature

Wrigley (2010) studied that energy was scarce in the pre-industrial economy which acted as a constraint to the economic growth of the country. According to him, the economy can overcome this constraint through the exploitation of fossil- fuels and later shifting to other modern sources of energy. Ruijen et. Al (2008) studied that research on energy and economic development has been done more on developed countries rather than developing countries because it is more likely to believe that the reason behind the developed countries today, energy would be the most driving factor. Boulding (1996), and Ayres and Kneese (1969) describe those physical laws describes the constraints of the economic situation because to carry out production, energy is required and secondly, energy can be reused. According to a study undertaken by Stern (1997), an essential factor of the production of energy and electricity is very much important, even to maintain the current level of economic activity. Evangelos Panos, et. al (2016) study that electricity access is low, and if people are taken, then still among 10 of them 2 live without electricity. So, the UN's "Sustainable Energy to All" aims at eradicating the electricity access deficit by 2030. Ramphul (2018) studied through the ARDL model that there is a robust relationship between electricity consumption and economic growth in the long- term and short- term. ADB (2005) and IEG (2008) analyzed that electricity is a means not an end, as it encompasses society with infrastructure that will improve welfare, productivity, and generation of income. Interaction between other development factors, infrastructure investment along with electricity leads to significant income generation and poverty alleviation (Mohd Pauzi & Shahadat Hossen, 2025).

Polemis and Dagoumas (2013) in their study analyzed that there is a bidirectional relationship between electricity consumption and economic growth in Greece. They analyzed that demand for long-run energy consumption was income elastic and price inelastic, however, both the elasticities are below unity in the long- run (Rahman, Hossain, et al., 2025). Maza, A. (2008), analyzed that there are three issues related to through which there is a reduction of disparities in the context of weak electricity consumption convergence: (a) experience of developing countries due to rapid change in economy; (b) Due to the first oil shock, many of the developed countries implemented energy conservation policies' (c) awareness issues related to energy consumption by developed countries (Rashed et al., 2025).

Purpose of the Study

The purpose of the study being undertaken is to analyze the relation between energy consumption and economic growth, along with the relation of electricity to economic growth. The study analyzes and compares the energy and electricity consumption done by 8 major countries of Asia selected on the basis of their GDP. The study will analyze the trends of consumption of energy along with electricity consumption in major countries of Asia. The paper is designed to see whether there is any significant role of energy and electricity in the development of the Indian economy. The study will help the policymakers for framing the appropriate policy in the context of the energy sector so as to promote inclusive growth of the country (Hossen et al., 2023).

Objective of the study

- To analyze the energy consumption of 8 selected Asian countries and compare their trends in the context of consumption.
- To analyze the relation between the consumption of energy (per capita) of India and its development (GDP per capita).
- Analyze the generation of electricity in India compared to other major countries of Asia.

- To analyze whether there is any relation between the per capita consumption of electricity in India and its development (per capita GDP).

Research Methodology

For the study to be undertaken we have taken the following four hypotheses to analyze the role and importance of energy and electricity in the development of an economy.

1. The null hypothesis H_0 taken is: Annual energy consumption in India is more as compared to other major countries of Asia. For which the alternative hypothesis is taken as H_1 is: Annual energy consumption in India is not more as compared to other major countries of Asia
2. The null hypothesis H_0 taken is: Per capita consumption of energy in India has increased with a rise in GDP (per capita). In this regard the alternative hypothesis is taken as H_1 : Per capita consumption of energy in India has not increased with a rise in GDP per capita.
3. The null hypothesis H_0 taken is: Electricity generation in India has increased more as compared to other major countries of Asia. The alternative hypothesis H_1 taken is: Electricity generation in India has not increased more as compared to other major countries of Asia.
4. The null hypothesis H_0 taken is: Consumption of electricity in terms of per capita in India has increased with the increase in per capita GDP. The alternative hypothesis H_1 taken is: Per capita consumption of electricity in India has not increased with the increase in per capita GDP.

For the analysis of data ANOVA, correlation and time series data analysis has been applied for the interpretation and their relation. Variables being undertaken are energy consumption, per capita, energy consumption, electricity consumption, per capita electricity consumption, by different countries of Asia considered, and per capita GDP of India. The test will analyze graphically and empirically the energy and electricity consumption and the impact of the per capita GDP of India on energy and electricity consumption (Alam et al., 2025).

Data Analysis

Table 1: ANOVA results of Energy consumption and average consumption according to country

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Rows	3803009	34	111853.2	8.743647	0.0000	1.48721
Columns	23597517	6	3932919	307.4392	0.0000	2.143231
Error	2609673	204	12792.51			
Total	30010198	244				
SUMMARY	Average					
China	10494.82455					
India	3134.5136					
Indonesia	4142.7456					
Iran	19341.23787					

Japan	39494.37745
Malaysia	18987.23653
Saudi Arabia	62928.94853
South Korea	32724.24409

Table 1 shows the analysis of ANOVA and the average consumption done by the countries of Asia taken under the study.

Table 2: ANOVA test for per capita energy consumption (Year wise- 35 years)

ANOVA						
Source of Variation	SS	D.f	MS	F	P-value	F crit
Rows	44045275065.794	54	815653242	13.03635458	0.000	1.371323
Columns	158976468115.778	7	22710924017	362.9822614	0.000	2.033819
Error	23650547675.179	378	62567586.44			
Total	226672290856.751	439				

Table 3: Per capita electricity consumption ANOVA test

<i>SUMMARY</i>	<i>Count</i>		<i>Sum</i>		<i>Average</i>	
<i>India</i>	35		19528.89		557.9682	
<i>Indonesia</i>	35		17116.66		489.0473	
<i>Iran</i>	35		74581.48		2130.899	
<i>Japan</i>	35		268031.6		7658.045	
<i>Malaysia</i>	35		105436.2		3012.462	
<i>Saudi Arabia</i>	35		245195.4		7005.582	
<i>South Korea</i>	35		227087.7		6488.22	
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Rows	339988173.9897	34	9999652.176	8.332705	0.00000	1.48721
Columns	2001558521.5728	6	333593086.9288	277.9829	0.00000	2.143231
Error	244809954.2890	204	1200048.796			
Total	2586356649.8514	244				

Correlation between Per capita (GDP and energy consumption)	
Correlation Coefficient(r) = 0.9819	
Coefficient of determination R ² = 0.9604	
Regression Statistics	
Multiple R	0.968279
R Square	0.937565
Adjusted R Square	0.903082
Standard Error	167.5023
Observations	30

Table 4: Correlation between per capita (GDP and electricity consumption)

Correlation between Per capita (GDP US\$ and electricity consumption)	
Correlation Coefficient(r) = 0.990896301	
Coefficient of determination R ² = 0.9801	
Regression Statistics	
Multiple R	0.963283826
R Square	0.927915729
Adjusted R Square	0.892201444
Standard Error	1256.484863
Observations	29

Table 4 and table 5 analysis tells analyze that per capita GDP with electricity per capita and energy holds a strong correlation. Figure 5 represents the trends of the relation between per capita energy consumption, per capita electricity consumption, and GDP per capita of India. In the given above figure we see that as the GDP per capita of India is increasing, consumption of both per capita (energy and electricity) is also increasing. The goodness of fit or coefficient of determination analyzed also says that there is a direct and positive relation between the consumption of energy/electricity with per capita GDP.

Limitations

The study has some constraints which are needed to be mentioned and are as follows:

- 8 Asian countries are taken for study considering their GDP sizes.
- The relation of growth of energy and electricity consumption is taken only for the 8 countries.
- Per capita GDP of India is considered so as to see the relation of growth with energy and electricity consumption.
- Only per capita GDP is considered as an indicator of growth under the study, all others remaining constant.

Conclusion

The null hypothesis of annual energy consumption in India is more as compared to other major countries of Asia is rejected as we can see in the above analysis that the p-value is less than α value $\{p(0.00) < \alpha(0.05)\}$. Thus, the statement taken H_0 is automatically rejected and the alternative hypothesis is accepted.

The null hypothesis of per capita consumption of energy in India has increased with a rise in GDP per capita, is accepted as we can see in the above analysis that goodness of fit and the correlation is very high which is $r = 0.9819$; coefficient of determination (r^2) = 0.9604 and $R^2 = 0.9375$. So, it is clear that per capita consumption of energy has increased as per capita GDP is increased.

The null hypothesis of electricity generation in India has increased more as compared to other major countries of Asia is rejected because the analysis results that the p-value is less than α value $\{p(0.00) < \alpha(0.05)\}$. Thus, the statement (H_0) is automatically rejected and the alternative hypothesis is accepted.

The null hypothesis of electricity consumption (per capita) in India has increased with the increase in GDP (i.e., per capita) is accepted, the reason being that we can see in the above analysis that goodness of fit and the correlation is very high which is $r = 0.9908$; coefficient of determination (r^2) = 0.9801 and $R^2 = 0.927$. so, it is clear that per capita consumption of energy has increased as per capita GDP is increased.

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Data Availability: The author holds all the data employed in this study and is open to sharing it upon reasonable request.

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