THE IMPACT OF FOREIGN DIRECT INVESTMENT (FDI) ON THE RELATIONSHIP BETWEEN RENEWABLE ENERGY CONSUMPTION AND GROSS DOMESTIC PRODUCT (GDP) IN KENYA

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Abstract

Energy consumption contributes a lot to the growth of economies worldwide. For developing African nations such as Kenya, where procedures, policies, and frameworks are still being developed, it is fundamental to recognize this linkage to come up with concrete policies and frameworks. The topic of climate change and environment, sustainability, and governance (ESG) are now discussion topics in all forums. Funding to developing nations for curbing the effects of climate change requires that governments formulate policies that will protect these funds to ensure they are used most efficiently. Different scholars have looked at the relationship between energy consumption and economic growth and found varied results across various countries in the world. This paper used the Vector Error Correction Model to test these variables' short-run and long-run relationships. This paper considered 3 variables – foreign direct investment (FDI), gross domestic product (GDP), and renewable energy consumption (REC). The data used was secondary for Kenya for the period 2002 to 2021 from the Kenya National Bureau of Statistics (KNBS). The vector error correction (VEC) Model was run and post-estimation tests were conducted on the data. The results concluded that there is a short-run bidirectional relationship between FDI & REC. Moreso, long-run unidirectional relationships are running from REC to GDP and from GDP to FDI. The Kenyan Government should work towards developing alternative sources of energy in the renewable energy space and boosting investments from foreign parties.

Keywords: Foreign Direct Investment (FDI), Gross Domestic Product (GDP), Renewable Energy Consumption (REC), and Vector Error Correction Model (VECM).

1. Introduction

Paul Samuelson, an esteemed Nobel laureate in economics in 1970, discussed how GDP serves as a fundamental measure of a country's economic output and activity. He underscored its role in evaluating economic performance, shaping policy decisions, and discerning trends in economic growth and development. The Bureau of Economic Analysis (BEA) gives a clear definition for GDP: Gross domestic product (GDP) is the value of the goods and services produced by the nation's economy less the value of the goods and services used up in production. GDP is also equal to the sum of personal consumption expenditures, gross private domestic investment, net exports of goods and services, and government consumption expenditures and gross investment. The most closely watched aggregate economic indicator and one that is so often used as a measure of the standard of living. Callen (2020) stated that GDP is important because it gives information about the size of the economy and how an economy is performing. The growth rate of real GDP is often used as an indicator of the general health of the economy. In broad terms, an increase in real GDP is interpreted as a sign that the economy is doing well. When real GDP is growing strongly, employment is likely to be increasing as companies hire more workers for the industries and the population has a lot of money to pocket. When GDP shrinks, as it has done in most economies this 2020, employment levels decrease. Many researchers have tried to find the causal relationship between energy consumption and revenue. There are original studies by Kraft and Kraft (1978) who found evidence in favor of causality running from income to energy consumption in the United States, by using data for period 1947–1974. This shows that energy conservation policies may be initiated without affecting the economy. Other empirical studies were later extended to focus on many developing countries as well to aid the execution of proper energy policies. Instead of only relying on the standard Granger causality test, researchers such as Masih and Masih (1996) and Glasure and Lee (1997) brought forth a varied perspective in recent studies encompassing the topic to show the causality between energy consumption and income for developing countries, using co-integration and error-correction techniques. The results of these researches are conflicting and varied. In the same breath, Soytas and Sari (2003) approximated causality for upcoming markets from the year 1950 to the year 1992, noting that a bi-directional causal relation exists for Argentina, but the co-integration vector was rejected for Indonesia and Poland. As per UNCTAD (1999) FDI is a long-term investment that reflects lasting control and interest of an entity in one country in an organization that is resident in another country. Other researchers like Reiter & Steensma (2010); Hermes & Lensink (2003); and Fernandes & Paunov (2012) observed that foreign direct investment is a key element in the growth of developing economies that have adequate capital to use for investment. Gajdzik et al. (2023) undertook a comprehensive study investigating the factors influencing the development of renewable energy sources (RESs) within the European Union (EU). The research focused on four primary categories of barriers: political, administrative, grid infrastructural, and socioeconomic. Utilizing publicly available data from sources such as European Union reports, Eurostat, and the Eclareon RES Policy Monitoring Database, the study encompassed all 27 EU member states. Its objective is to assess the impact of various factors, including socioeconomic ones, on RES development across these countries. One key finding of the analysis challenges the notion of uniformity in RES advancement and barriers across the EU. The research identified a significant correlation between the level of societal development and the integration of renewable energy sources. Yolcan (2023) conducted an assessment of the global energy landscape and the progress of renewable energy development within the timeframe of 2012 to 2021. The study focused on evaluating the contribution of renewable energy to electricity production and primary energy consumption, analyzing its growth trajectory over the specified period. The findings indicate a consistent rise in interest and utilization of renewable energy resources over the years. Analysis of global energy data reveals a significant increase in both installed capacity and consumption of renewable energy during the study period. They also noted that foreign direct investment contributed to the growth of developing countries' economies not just for capital financing, but also for aiding the countries to boost their productivity.

Taspinar and Gökmenoğlu (2016), noted that there was causality from the growth in the economy to foreign direct investment for Turkey. These results show that in Turkey foreign direct investment is driven by the state of the economy. In essence, this implies that stable growth in the economy produces a friendly environment for investments. Jensen (1996) declared that a mature financial sector facilitates attracting foreign direct investment (FDIs) and may encourage economic growth, this would also boost pollution from industrialization and therefore decrease the quality of the environment. He advised that the interlinkage between growth in the economies and foreign direct investment is vital in developing countries. The purpose of this research is to explore what function FDI has on the relationship between gross domestic product and the consumption of renewable energy in Kenya. Establishing the role that foreign direct investment plays would aid the Kenyan government in enforcing regulations that are more attractive to foreigners for investing. The Kenyan Government has put in place a Foreign Investments Protection Act. From the African economic outlook (2020) Kenya's real gross domestic product increased by about 5.9% in the year 2019 and this was attributed to investment and domestic consumption at the demand side. Many services contributed to this including; insurance & banking, warehousing, transport & logistics, ICT as well as administration.

Both Zhang (2001) and Nyamwenga (2009), opine that an increase in FDI specifically in the energy sector has led to industrialization, an increase in employment levels, improved living standards, especially in rural areas, and reduction in poverty levels. Nyamwenga (2009) further observes that FDI inflows to Kenya are important since it acts as a capital source, given the fact that foreign assistance has been declining in the past years. The study concludes that FDI promotes investments in the local country, generates employment opportunities, and boosts economic growth. In addition, he found out that FDI does not only grant capital to African countries for domestic investment, but it also assists in transferring managerial & technical skills and avails employment chances, all of these factors are a contribution to economic development. With the recognition that FDI contributes immensely to economic development, then all governments in Africa including Kenya would want to attract it. As per Semboja (1994) the Kenyan Government can implement energy-efficient policies which would lead to a reduction on the dependence on foreign energy purchases, advancement of reliable local energy purchasing, and the conservation of different energy sources, hence saving on foreign currency and boosting good environmental practices. The general objective of this study was to examine the relationship between energy consumption and economic growth in terms of GDP (Growth Domestic Product) in Kenya. The questions the study seeks to answer are as below.

1. What is the relationship between renewable energy consumption and economic growth in Kenya?

2. What is the relationship between renewable energy consumption and foreign direct investment?
3. What is the relationship between foreign direct investments, and economic growth in Kenya?
4. What is the relationship between renewable energy consumption and economic growth in Kenya with foreign direct investment as a moderating variable?
5. What is the type of bi-directional relationship between energy consumption and economic growth in Kenya with foreign direct investment as a moderating variable?

This paper is divided into five sections which are: Section 2 summarizes literature from previous studies. Section 3 defines the data description, the data analysis and the model used. Discussions of the results are in Section 4. The last section 5, concludes this study.

2. Literature Review

2.1. Previous Empirical Studies

Dunne and Aslay (2005), describe Kenya as a nation in Africa to the eastern part of the continent, which has endeavored to work for the stability of its economy from when it got its independence from Britain in 1964. Despite several efforts by the central bank and the government of Kenya to grow the economy, the country has remained in a pattern of domestic deficits and huge external debts with a slow-moving GDP growth rate. The GDP for Kenya in 2003 was at KES. 1.04 trillion translated as 13.8 billion USD. In the year 2003, Kenya experienced a very slow and varying growth from one year to the next. In the '60s and '70s, the GDP in Kenya fluctuated uncontrollably from 23% to minus 5%, due to several factors, which included; shortages in the World oil in the 70s, gaining political independence from the British, an increase in the global coffee demand– being a dominant export for the country in the years 1976 and 1977 as well as the fall of the East African Community which occurred in 1977. Onuonga (2012) probes the sources of energy in Kenya which encompass non-commercial and commercial usage. The non-commercial alternatives are mostly biomass and to a small extent, there is biogas, solar energy, and wind energy while commercial energy sources include electricity and petroleum products. Petroleum fuel is the leading source of modern energy for Kenya with a proportion of about 20% of the total consumed energy. Petroleum consumption in 2006 was 3038.2 thousand tones and went up to 3121.8 thousand tones in the year 2007. Duce (2003) investigates the methodological aspect of FDI about International Investment Position (IIP) and the Balance of Payments (BoP). The financial system is a focal point because of its importance both as a sender (domestic perspective) and a receiver (host perspective) of direct foreign investment. The paper defines terms like "direct investor" and "direct investment enterprise" (associate, subsidiary, and branch), as well as describing the various sector divisions available and their implications for FDI in the financial sector. In this report, the researcher takes a look back at the primary data points he has on FDI, and he highlights the disparities between the estimates of how much FDI is flowing into emerging markets and how much is sitting in stock in industrialized nations.

Rennkamp et al. (2017) investigate the political climate surrounding renewable and carbon fuels in South Africa, Mexico, and Thailand. Despite having cheap local fossil fuel resources and no international backing, this research examines the reasons why middle-income countries are encouraging renewable energy. In their study, researchers compare the renewable energy policy environments of South Africa, Mexico, and Thailand. The energy resources of all three nations, both fossil fuel and renewable, are extensive. Researchers contend that alliances of powerful political players make renewable energy initiatives a viable policy alternative in fossil fuel energy-rich middle-income nations. Abbas et al. (2020) stated that wind energy continues to have a huge impact on the continent of Africa because of its decreasing cost and improvement in technology over the years. Many countries in the continent of Africa are Most African countries are trying to plan, exsiccate and connect the renewable energy projects within their national grid systems whilst giving higher priority to security of energy, consumption of energy that is sustainable and little emissions of carbon. Many policy frameworks have been established in these countries for promoting the upscaling of wind energy as well as renewable energy all over the World. However, these policies have had mixed reactions to the distribution of wind energy. Boehlert and Gill (2010) stated that the potential impacts on the environment have not been adequately studied and the devices to be used are yet to be evaluated and tested. Similarly, Hussaina et al., (2017) discuss the five most emerging renewable energy sources. These alternative energy sources are either novel developments or variations on more established renewables including solar, wind, geothermal, biofuels, biogas, and hydropower. The five emerging renewable technologies comprise Marine energy, concentrated solar photovoltaic (CSP), enhanced geothermal energy (EGE), cellulosic ethanol, and artificial photosynthesis. Ocean thermal energy conversion, salinity gradient energy, wave energy, and tidal energy are the various forms of marine energy. Various concentrated solar power (CSP) technologies are classified as either parabolic troughs, linear Fresnel reflectors, parabolic dishes, or solar towers.

Demirbas (2006), in his article, proves that renewable energy sources provide more than 14% of the total energy in the world. These sources, comprising hydropower, geothermal, solar, wind, and marine energies are clean and inexhaustible. In 1995, biomass accounted for a percentage share of 62.1% of the total amount of renewable energy sources. Twenty percent of the world's electricity comes from hydropower generated at large scales. Wind energy in coastal areas and other areas prone to wind also holds a lot of potential. Four researchers named Bain, Amos, Downing, and Perlack (2003) argue that Biopower is currently the largest source of non-hydro renewable electricity with approximately 11 GW of installed capacity. This makes biopower the most viable alternative to hydroelectric power in the United States. This 11 GW of capacity includes approximately 7.5 GW of capacity from the residues of forest products and agricultural industries, approximately 3.0 GW of capacity from the generation of electricity based on municipal solid waste, and approximately 0.5 GW of capacity from other sources, such as production based on landfill gas. It has been demonstrated in a research project carried out by Wieliczko and Stetson (2020) that hydrogen is a flexible energy storage medium with tremendous potential for incorporation into the upgraded grid. Adsorbents, metal hydrides, and chemical carriers are examples of some of the cutting-edge materials that are being developed for use in hydrogen energy storage technologies. These materials play an important part in making the ultimate use of hydrogen. The Hydrogen and Fuel Cell Technologies Office of the United States Department of Energy is in charge of research and development conducted on hydrogen and other fuel cells. These activities, which include hydrogen energy storage, are designed to promote tenacity and the optimal use of a variety of domestic energy resources. Hydrogen technologies provide a wide range of options for producing and storing energy sustainably and efficiently, which is a rapidly developing field. Rehman and Mujahid (2017) discuss the importance of ensuring a reliable supply of electrical power in Pakistan. They also present an outline of the country's current energy use while considering several perspectives on the power industry. These include the supply-and-demand gap, the depletion of energy supplies, the threat to energy security, and the rising cost of power. Ting, Yin and Yin (2011) delve into the reduction of the consumption of energy for China specifically the Jiangsu Province, they suggested that while the FDI scope is being expanded then there should be the adoption of emission-reducing and energy-saving policies and guidelines. They note that the province should expand the FDIs which are in technology-intensive but at the same time utilize energy-saving technologies. Furthermore, there is a need to adjust the structure and framework in the distribution industry of FDIs in order to take advantage of the adjustments in the industrial structures.

According to Muhammad and Majeed (2015) the growth in the economy, financial & commerce openness and consumption of energy linkages in South Asia. Results show that trade, FDI, and energy have a positive impact on the growth in the economy, there is a bidirectional linkage in the long term between energy and growth and a unidirectional relationship from commerce and financial advancement to economic growth for five South Asian countries for a period between 1980 to 2010. In a similar study, He, Gao and Chong (2012) interrogated the direction and presence of linkage between foreign direct investment, consumption of energy and the growth in the economy in China between 1985 and 2010. They found out that there is unidirectional relationship from gross domestic product to the use of energy and from FDI, and a unidirectional relationship from consumption of energy consumption to foreign direct investment. Furthermore, results revealed that increasing FDI inflows have a substantive energy-saving impact.

2.2. Hypotheses for the Study

There are four hypotheses in this study described as below.

Hypothesis 1.

H_0; There is a statistically significant relationship between renewable energy consumption and economic growth.

H_1; There is no statistically significant relationship between renewable energy consumption and economic growth.

Hypothesis 2.

H_0; There is a statistically significant relationship between renewable energy consumption and foreign direct investment.

H_1; There is no statistically significant relationship between renewable energy consumption and foreign direct investment.

Hypothesis 3.
$H_{0:}$ There is a statistically significant relationship between foreign direct investment and economic growth.
$H_{1:}$ There is no statistically significant relationship between foreign direct investment and economic growth.
Hypothesis 4.
$H_{0:}$ There is a statistically significant bi-directional relationship between energy consumption and economic growth.
$H_{1:}$ There is no statistically significant bi-directional relationship between energy consumption and economic growth.

2.3. Theoretical Framework

The Energy Consumption Theory was utilized for this study.

Vosooghzadeh (2020) defined Energy Cost Theory which is often referred to us as Energy Consumption Theory states that cost of utilizing energy resources in operations, services and production is compensated by the long-term positive economic effect of the said engagements. These engagements or businesses could utilize the income that is generated in performing research and development (R&D) in order to ensure there is investment in combined energy-resource technologies. This will enable them to reduce hazardous emissions to the environment as well as lowering the costing of energy production. These positive economic effects are brought about by incremental and the remaining innovations in those businesses and result in total improvement of the economy because of the demand which is arbitrarily induced causing a multiplier-effect on the monetary transactions. Additionally, the stated demand that is induced improves monetary transactions, therefore, boosting the economy and improving the standards of living of the population. The original decision to boost consumption of energy is part of business introductory innovations, whilst the dynamic impact which can reduce the cost of consumption of energy in the forestated businesses forms part of business far-reaching innovations.

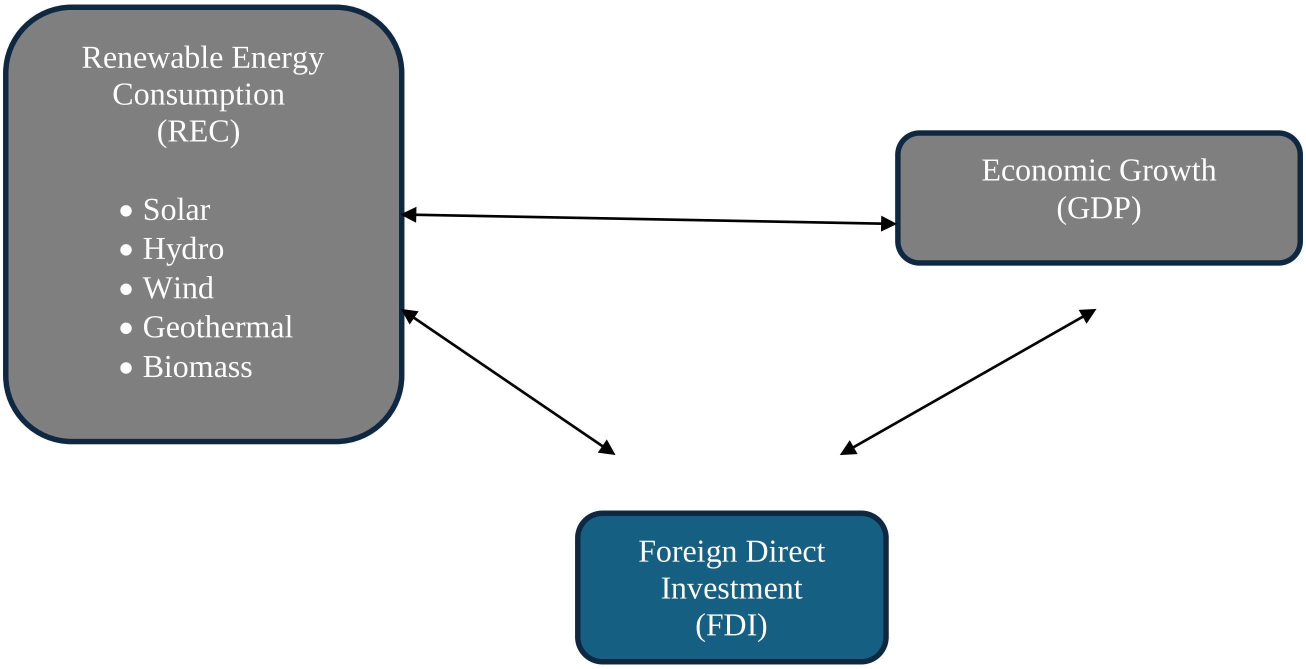

Figure 1: Conceptual Framework, Source: Author (2020*)*

3. Data, Sample, and Model specifications

3.1. Data Description

This study considered 80 time series observations for all the variables that is, these are 20 quarters from January 2002 up to and including December 2021. Data was collected from the Kenya National Bureau of Statistics (KNBS). A summary of their basic characteristics is as per the representation in the below table. The data measurements were different; gross domestic product is measured in Trillions Kenya shillings; renewable energy consumption is measured in Gigawatt hours while foreign direct investment is measured in Millions Kenya shillings. The data for this study was enormous and normalized to fit the analysis in STATA software.
Table 1 below shows the descriptive results indicate no value that is an outlier and that all the data values lie within the acceptable limits. George & Mallery (2010) explained that the values for kurtosis and asymmetry should lie between positive 2 and negative 2 to have a normal univariate distribution, which is the case for all the variables below.

Table 1 Descriptive Analysis

	Log_gdp	**Log_fdi**	**Log_rec**
Mean	6.7625	6.7474	6.1779
Median (p50)	6.9202	7.3636	5.9630
Minimum	5.4530	2.8820	4.4152
Maximum	8.0642	8.4731	7.8248
Standard Deviation	0.8809	1.4533	0.9054
Skewness	0.6121	0.0002	0.8244
Kurtosis	0.0000	0.9754	0.0000
Observations	**80**	**80**	**80**

Log_gdp has a mean of 6.7625 and a median of 6.9202, the minimum value of the log_gdp is 5.4530 while the maximum value is 8.0642. Log_fdi has a mean of 6.7474 and a median of 7.3636, the minimum value of log_fdi is 2.8820 while the maximum value is 8.4731. As for log_rec, its mean is 6.1779 and a median of 5.9630, the minimum value of the log_rec is 4.4152 while the maximum value is 7.8248. All the medians are means are close and this indicates that the data set has a symmetrical distribution. A skewness value greater than 1 or less than -1 indicates a highly skewed distribution which is not the case for any of the variables.

3.2. Correlation Analysis

Daoud (2017) made 3 conclusions; Multicollinearity causes severe problems in data analysis and must be remediated before data modeling is done, there is a great recommendation that all assumptions of a regression analysis must be adhered to since they contribute to the accuracy of the conclusions and would assist in inferring to the population and a scholar should dismiss and ignore the whole model if multicollinearity is discovered this is because the model will not be able to be interpreted. In this study, table 2 shows the correlation coefficients run on Stata (using the command; correlate gdp fdi rec)

Table 2 Correlation Matrix

Variables	Log_gdp	Log_fdi	Log_rec
Type of Variable	**Dependent Variable**	**Moderating Variable**	**Independent Variable**
Log_gdp	1.0000		
Log_fdi	0.6913***	1.0000	
Log_rec	0.9244***	0.5776***	1.0000

There is a strong positive relationship between log_gdp and log_fdi (0.6913). This indicates that when gross domestic product increases, foreign direct investment increases and when gross domestic product decreases, foreign direct investment also decreases. There is also a strong positive relationship between log_gdp and log_rec (0.9244) indicating that when gross domestic product rises, renewable energy consumption rises, and when gross domestic product declines, renewable energy consumption declines as well. There is a moderate positive relationship between log_fdi and log_rec (0.5776). This shows that when foreign direct investment goes up, renewable energy consumption will also go up and when foreign direct investment goes down then renewable energy consumption will also go down. There is no inverse relationship between any of the variables in the study. The results of this correlation test are aligned with those of Moolio and GuechHeang (2013) who claimed that FDI positively affects GDP.

3.3. Stationarity Tests

Stationarity was assessed. For the stationarity test in this study, the null hypothesis (H_o) was non-stationarity whereas the alternative hypothesis (H_a) was for stationarity. Majority of macro-economic data is assumed to be integrated of order one I (1). There is need to confirm this before proceeding to fit the appropriate multivariate model. The stationarity test was used by Abid and Sebrri (2011) in their study of “Energy Consumption-Economic Growth Nexus: Does the level of aggregation matter?” The Null hypothesis (Ho) is non-stationarity while our alternative hypothesis (HA) is stationarity. Table 3 presents the results of the Dickey-Fuller test run on Stata for both the variables and their first differences; the critical values at the different levels of significance (1%, 5% & 10%) are also displayed at the bottom of the table. The p-values at level for log_gdp, log_fdi, and log_rec are 0.9090, 0.1306, and 0.3281 respectively. None of the logarithms of variables is stationary at level. The p-values at the first difference for log_gdp, log_fdi, and log_rec are all 0.0000, showing that they are stationary at 1^{st} difference.

Table 2 Dickey-Fuller Test

variables	Level			First Difference		
	Test statistic		p-value for Z(t)	Test statistic	p-value for Z(t)	
Log_gdp	-0.407		0.9090	-10.017	0.0000	
Log_fdi	-2.441		0.1306	-10.407	0.0000	
Log_rec	-1.908		0.3281	-12.667	0.0000	
	Critical values			Critical values		
	1%	5%	10%	1%	5%	10%
	-3.539	-2.907	-2.588	-3.541	-2.908	-2.589

The Dickey-Fuller has the null hypothesis (H_0) for data having a unit root (non-stationarity) against an alternative hypothesis (H_A) of no unit root (stationarity). The null hypothesis is accepted because, in the Dickey fuller test, the test statistic is less than the critical values at the different levels of significance. The alternative hypothesis stating that there is stationarity is rejected. The test implies that the variables are non-stationary at level and stationary when differenced to order 1.

3.4. Lag selection

Table 4 below shows the results of the number of lags to be included in the model from the different information criteria methodologies.

Table 4 Lag Selection Criteria

Selection-order criteria
Sample: 6 - 80 Number of obs = 75

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	12.1677				5.7e-07	-0.1911*	-.129448*	-0.0367*
1	35.7558	47.176	25	0.005	5.9e-07	-0.1535	0.2167	0.7735
2	53.5144	35.517	25	0.079	7.2e-07	0.0396	0.7182	1.7391
3	82.2205	**57.412***	25	0.000	**6.7e-07***	-0.0592	0. 9278	2. .4128
4	96.8053	29.17	25	0.257	9.2e-07	0.2185	1.5140	3.4630

Endogenous: D.log_gdp D.log_fdi D.log_rec
Exogenous: _cons
FPE: Final Prediction Error
AIC: Akaike Information Criterion
SBIC: Schwarz Bayesian Information Criterion
HQIC: Hannan-Quinn Information Criterion

The results in Table 4 above indicate that the Hannan-Quinn Information Criterion, the Akaike Information Criterion, and the Schwarz Bayesian Information Criterion have chosen no lag for the model (lag zero with the asterisks); while the likelihood ration (LR) and the Final Prediction Error have proposed that three lags be included in the model. The decision criterion is normally to choose and use the number of lags preferred by most criteria. As seen in the above results, three lags will be used in the model.

3.5. Co-integration test

Time series are said to be co-integrated if they co-move towards long-run equilibrium. The Johansens methodology was utilized to determine if there is co-integration in the series and therefore fit the appropriate model. In the case of this study, the appropriate model would be the vector autoregressive (VAR) model if no co-integration exists or the vector error correction model (VECM) if co-integration exists. The use of either VAR or VECM was well demonstrated by Pramesti, Aziza, and Suharsono (2017) in their comparison of vector autoregressive (VAR) and vector error correction models (VECM) for an index of the Association of Southeast Asian Nations (ASEAN) stock price. To find out the existence of both short-run and long-run equilibrium relationships among the variables in this study, the Johansen co-integration test was performed as per Table 5 below in Stata V.12.0 and utilizing four lags as determined in the lag selection information criteria. The null hypothesis (H_o) is that there is no co-integration while the alternative hypothesis (H_A) is that there is co-integration. From the first table below, the trace statistics for maximum ranks 0, 1, 2, and 4 are all more than the critical values at 5% and therefore we reject the null hypothesis (which states that there is no co-integration) and accept the alternative hypothesis which states that there is co-integration.

Table 5 Johansen co-integrating Test

Trend: constant — Number of obs = 76
Sample: 5 - 80 — Lags = 3

Maximum rank	parms	LL	eigenvalue	Trace statistic	5% Critical value
0	55	-27.6753	.	217.9404	68.52
1	64	22.9725	0.73627	116.6448	47.21
2	71	52.9884	0.54611	56.6130	29.68
3	76	64.8176	0.26750	32.9546	15.41
4	79	74.8412	0.23186	12.9073	3.76
5	80	81.2949	0.15619		

Maximum rank	parms	LL	eigenvalue	SBIC	HQIC	AIC
0	55	-27.6753		3.86238	2.849758	2.8498
1	64	22.9725	0.7363	3.0424	1.864071	1.0797

2	71	52.9884	0.5461	2.6514	1.344181	0.4740
3	76	64.8176	0.2675	2.6250	1.225747	0.2943
4	79	74.8412	0.2319	2.5322	1.077684	0.1094
5	80	81.2949	0.1562	2.4194	.9464223	-0.0341

3.6. VEC Model

Table 6 Model Fitness

Sample: 5 - 80	No. of obs = 76
	AIC = 1.079672
Log likelihood = 22.97248	HQIC = 1.864071
Det (Sigma_ml) = 3.76e-07	SBIC = 3.042394

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D2_log_gdp	12	0.0884	0.4501	52.3946	0.0000
D2_log_fdi	12	0.6568	0.5363	74.0190	0.0000
D2_log_rec	12	0.2576	0.8360	326.1607	0.0000

From Table 6 above, the Parms show the number of parameters for this study is 12. The RMSE is the root mean square error which shows the standard deviation. The R-sq is the R squared that explains the proportions; gross domestic product for the current quarter is explained by 45.01% of its own lags and the lags of foreign direct investments and renewable energy consumption. Foreign Direct Investment for the current quarter is explained by 53.63% of its own lags and the lags of Gross Domestic Product, and renewable energy consumption. Renewable energy consumption this quarter is explained by 83.60% of its own lags and the lags of gross domestic product, and foreign direct investments. All the 3 model variables; gross domestic product, foreign direct investment and renewable energy consumption are significant 1% since the P>chi2 = 0.0000 which is less than 0.05.

Table 7 Speed of Adjustment

_Cel L1

	Coef.	Std. Err	z	p>|z|	[95% Conf. Interval]	
D2_log_gdp	-0.0206	0.0250	-0.82	0.410	-0.0696	0.0284
D2_ log_fdi	0.5471	0.1858	2.94	0.003	0.1829	0.9112
D2_ log_rec	0.9055	0.0728	12.42	0.000	0.7626	1.0483

Model specification

Definition of the terms;

Δlog_gdp_t, Δlog_fdi_t, and Δrec_t are first differences i.e. $\Delta log\_gdp_t = log\_gdp_t - log\_gdp_{t-1}$, $\Delta log\_fdi_t = log\_fdi_t - log\_fdi_{t-1}$, $\Delta log\_rec_t = log\_rec_t - log\_rec_{t-1}$

μ, €, Ł - These are the coefficients of the variables, they define the short-run relationship between the variables

$\beta_{11}, \beta_{21}, \beta_{31}$ -These are the coefficients for the long-run correlation/relationship between variables.

$\wp_{1t}, \wp_{2t}, \wp_{3t}$ – These are the white noise/shock terms

$\alpha_{10}, \alpha_{20}, \alpha_{30}$ - These are constants.

$\{\infty + gdp_{t-1} - \alpha_{12} fdi_{t-1} + \alpha_{15} rec_{t-1}\}$-This is the error correction term per variable and corrects values for the previous period. This term corrects the previous errors and ensures differences are not zero.

The Vector Error Correction Model was fitted with the 3 variables of the study as below.

$$\Delta log\_gdp_t = \alpha_{10} + €_{11}\Delta log\_gdp_{t-1} + \mu_{11}\Delta\ log\_fdi_{t-1} + Ł_{11}\Delta log\_rec_{t-1} + \beta_{11}\{\infty + log\_gdp_{t-1} - \alpha_{12}\ log\_fdi_{t-1} + \alpha_{15}\ log\_rec_{t-1}\} + \wp_{1t} \ldots\ldots\ldots (a)$$

$$\Delta log\_fdi_t = \alpha_{20} + \mu_{21}\Delta log\_fdi_{t-1} + €_{21}\Delta log\_gdp_{t-1} + Ł_{21}\Delta log\_rec_{\ t-1} + \beta_{21}\{\infty + log\_gdp_{t-1} - \alpha_{12}\ log\_fdi_{t-1} + \alpha_{15}\ log\_rec_{t-1}\} + \wp_{2t} \ldots\ldots (b)$$

$$\Delta log\_rec_t = \alpha_{50} + Ł_{51}\Delta log\_rec_{\ t-1} + €_{51}\Delta log\_gdp_{t-1} + \mu_{51}\Delta log\_fdi_{t-1} + \beta_{51}\{\infty + log\_gdp_{t-1} - \alpha_{12}\ log\_fdi_{t-1} + \alpha_{15} log\_rec_{t-1}\} + \wp_{5t} \ldots\ldots (c)$$

The equations are as below.

$$\underset{(0.010)}{\Delta log\_gdp_t = -0.0008} - \underset{(0.124)}{0.662}\Delta log\_gdp_{t-1} - \underset{(0.016)}{0.014}\Delta log\_fdi_{t-1} - \underset{(0.057)}{0.019}\Delta rec_{t-1}$$

$$- \underset{(0.025)}{0.0206}\{0.079 + log\_gdp_{t-1} - \underset{(0.112)}{0.325} log\_fdi_{t-1} - \underset{(0.264)}{3.11} log\_rec_{t-1}\} \ldots \textbf{I}$$

$$\Delta log\_fdi_t = \underset{(0.075)}{-0.062} - \underset{(0.120)}{0.678}\ \Delta log\_fdi_{t-1} + \underset{(0.897)}{0.294}\Delta log\_gdp_{t-1} + \underset{(0.427)}{1.391}\Delta log\_rec_{\ t-1}$$

$$- \underset{(0.186)}{0.547}\{0.079 + log\_gdp_{t-1} - \underset{(0.112)}{0.325} log\_fdi_{t-1} - \underset{(0.264)}{3.11} log\_rec_{t-1}\} \ldots \textbf{II}$$

$$\Delta log\_rec_t = \underset{(0.030)}{0.0042} + \underset{(0.167)}{1.140}\Delta log\_rec_{\ t-1} - \underset{(0.131)}{0.027}\Delta log\_gdp_{t-1} + \underset{(0.047)}{0.188}\Delta log\_fdi_{t-11} +$$

$$\underset{(0.073)}{0.906}\{0.079 + log\_gdp_{t-1} - \underset{(0.112)}{0.325} log\_fdi_{t-1} - \underset{(0.264)}{3.11} log\_rec_{t-1}\} \ldots \textbf{III}$$

The summary of the results for the values is as below;

Table 8 Vector Error Correction Model Values

		Coef.	Std.Err.	z	p>|z|	[95% Conf. Interval]	
	Table 8.1						
D2_gdp	Log_gdp						
	LD2.	-0.6622	0.1239	-5.49	0.000	-0.8987	-0.4256
	Log_fdi						
	LD2.	-0.0145	0.0162	-0.90	0.369	-0.0462	0.0172
	Log_rec						
	LD2.	-0.0191	0.0574	-0.33	0.740	-0.1316	0.0934
	Table 8.2						
D2_fdi	Log_gdp						
	LD2.	0.2940	0.8971	0.33	0.743	-1.4644	2.0524
	Log_fdi						
	LD2.	-0.6784	0.12023	-5.64	0.000	-0.9141	-0.4428
	Log_rec						
	LD2.	1.3912	0.4268	3.26	0.001	0.5548	2.2276
	Table 8.3						
D2_rec	Log_gdp						
	LD2.	-0.0269	0.3519	-0.08	0.939	-0.7166	0.6629
	Log_fdi						
	LD2.	0.1882	0.0472	3.99	0.000	0.0958	0.2806
	Log_rec						
	LD2.	1.1402	0.1674	6.81	0.000	0.8121	1.4683

The shock of one variable affects another variable in the long-term.

Table 9 Orthogonalized Impulse Response Functions

Log_gdp IRFs – Table 9.1

step	(1-log_gdp) oirf	(2-log_fdi) oirf	(3-log_rec) oirf
0	.088353	.146109	.035613
1	.027878	.068872	.023353
2	.054213	.046224	-.037882
3	.046533	.044588	-.024425
4	.045652	.100349	.038867
5	.048785	.068837	.006819
6	.046733	.061125	-.01927

7	.048195	.054795	-.015858
8	.046222	.076663	.022951
9	.047751	.081308	.002915
10	.047727	.056028	-.011
11	.047042	.061291	-.007102
12	.047308	.077093	.009284

Log_fdi IRFs -Table 9.2

step	(6-log_gdp) oirf	(7-log_fdi) oirf	(8-log_eec) oirf
0	0	.640364	.00881
1	-.003075	.08007	-.067426
2	-.008137	.201324	.010873
3	.005708	.354429	-.084529
4	-.009676	.216676	.040033
5	-.000346	.242524	-.039641
6	-.001408	.283824	-.040882
7	-.004538	.223373	-.028426
8	-.002472	.26584	.002569
9	-.002129	.271576	-.037227
10	-.003104	.234265	-.027859
11	-.0027	.251771	-.025655
12	-.002825	.270967	-.01553

Log_rec IRFs Table 9.3

step	(21-gdp) oirf	(22-fdi) oirf	(25-rec) oirf
0	0	0	.249643
1	.011214	-.077514	-.168828
2	.00301	-.124734	-.023741
3	.000855	-.050322	.041568
4	.004853	.035273	.108859
5	.005828	-.097083	-.0638
6	.003366	-.098778	-.018284
7	.003905	-.036364	.028203
8	.002964	-.01612	.063008
9	.005626	-.076622	-.022994
10	.003866	-.075492	-.011492
11	.00359	-.047556	.022262
12	.003744	-.036527	.039121

4. Discussion of results

4.1. Renewable energy consumption and gross domestic product

Equations I and III, present the short-term relationship, after renewable energy consumption rose by one unit (1%) in the past quarter, the gross domestic product will decrease by 2.7% in the current quarter but not significantly. After the gross domestic product increased by one unit (1%) in the last quarter, renewable energy consumption will increase by 1.9% but not significantly. Table 9.1 shows that in the long term, immediately there is a shock in the gross domestic product, and there is an increase in renewable energy consumption by 0.035 units. A shock in gross domestic product has a transitory effect on renewable energy consumption over the subsequent 12 periods- some quarters have positive increases in units while others have negative. Immediately there is a shock on renewable energy consumption, there is no effect on GDP. The shock is permanent as all quarters have positive values. Lehmann et al. (2017) observe that compared to solar and wind, the energy density of ocean waves is far higher and is much more predictable. Furthermore, in the case of the US, resource sites with significant wave power are near major load centers, as coasts tend to be where most of the country's population resides. Due to these factors, there has been a rise of interest in the US in attempting to economically exploit ocean wave power. The objective of this article was to analyze the current status of ocean wave energy transformation technology Research and Development (R&D), and government backing in the US and to provide some insight into its potential future. Active research teams and commercial ventures have been uncovered, as have current infrastructure, software, and open-water experimental facilities and resources. Although the United States is home to more than a third of the world's economically active wave energy companies, very few have achieved a very high-tech Readiness Level. These results, along with the existence of a useful practical resource and the benefits it offers, suggest that the United States is prepared to lead the way in the development of the wave energy industry.

4.2. Renewable energy consumption and foreign direct investment

Table 9.3 shows that at the instance when there is a distraction in REC, there is zero impact on FDI, which then drops by 0.08 units in the first quarter. The shock on REC causes increases and decreases in FDI units in the next twelve quarters causing an impermanent shock. At the moment when there is a disturbance in FDI, there is also an impermanent impact on REC as the units are positive and negative over the next 12 periods. According to Maubleu et.al. (2006), energy is the basis for all human endeavors; therefore, it's exciting to consider the potential of solar water heaters for Pakistan's textile industry. Pakistan's primary energy source has always been fossil fuels. However, the rapid depletion of fossil fuels and their connection to increasing global warming are two important issues. It is now generally understood that traditional energy sources like fossil fuels and nuclear power must be rapidly supplanted by renewable sources if sustainable development is to be achieved. The latter are environmentally beneficial and can provide enough energy to meet current and forecast world needs. Obeng and Hans-Dieter (2009) in their paper "Solar PV rural electrification and energy poverty" review the conceptional framework in Ghana. Despite the fact that governments aim to enhance the incorporation of renewable power in electricity supply, specifically solar photovoltaic for energy alleviating poverty in remote regions of Africa, there seems to be relatively little knowledge on how solar Photovoltaic electrification implications on energy poverty reduction. As a result, there is a lack of relevant published material, calling for ongoing study. Solangi et al. (2011) observe that many nations have looked into and switched to renewable, ecologically friendly energy sources in order to meet their rising energy needs in light of the environmental repercussions and other challenges associated with burning fossil fuels. When compared to other renewable energy options, solar has one of the minimal environmental impacts. Numerous nations' governments have enacted solar energy initiatives to lessen their reliance on imported fossil fuels and boost homegrown solar power.

4.3. Foreign direct investment and gross domestic product

Equations I and II imply that when the foreign direct investment escalates by a unit in the current quarter, GDP will go up by 29.4% in the next quarter statistically insignificantly. A unit increase in GDP, makes FDI decrease by 1.4% but not significantly. Table 9.2 notes that when there is an impact on FDI, it does not affect GDP immediately. It has a non-permanent effect going forward with increases and decreases in the units over the subsequent twelve periods. A disturbance in GDP has a permanent/ long-lasting positive impact on FDI, all the values in the consecutive twelve quarters are positive. The finding from this study is in line with Mavrotas and Chowdhury (2006) who examined the causality between economic growth and foreign direct investment by applying the Toda-Yamamoto test for 3 developing economies and found that GDP impacts FDI but not vice versa. These findings however go against Hansen and Rand (2006), who found out that foreign direct investment has a perpetual effect on the gross domestic product of the thirty-one countries while the gross domestic product has no long-lasting effect on the foreign direct investment of these economies.

4.4. Bidirectional Relationships

There is a bidirectional relationship between renewable energy consumption and foreign direct investment. Equations II and III explains that, in the quarter that the foreign direct investment increases by one unit (1%), then renewable energy consumption will increase by 139.1% in the next quarter, and this is statistically significant. In the quarter that renewable energy consumption goes up by one unit (1%), then foreign direct investment goes up by 18.8% which is statistically significant. Khandker, Khan, and Amin (2018) in their research find that FDI and the use of renewable energy are intertwined in both the short and long term. However, they observed no short-term causal link between renewable energy usage and FDI. Timilsina, Kurdgelashvili and Narbel, (2011) examine the technological, economic, and policy facets of solar energy creation and implementation. Despite significant price reductions over the past few years, solar energy is still prohibitively expensive compared to more traditional sources of power. Regulatory and financial incentives and mandates, such as tax credits and rebates, feed-in-tariff, favorable rates, policy measures, and optional green power programs, are all to the benefit of solar energy, just as they are for other energy sources. Potential growth in carbon credit markets might also boost incentives for solar energy deployment, although current carbon market mechanisms like the "Clean Development Mechanism of the Kyoto Protocol" can only go so far. Solar energy technologies have enormous technical capacity, but there are still many technical and financial hurdles that need to be cleared before they can be developed and used on a global scale in response to market forces. The continued implementation of possibly expensive governmental supports will be necessary to keep and expand solar-generated electricity supplies until these obstacles are removed.

5. Conclusion

This paper researched the impact of foreign direct investment and how it links to the relations between the usage of renewable energy and the growth of the Kenyan economy. In measuring the economic growth of the country, the gross domestic product (GDP) was considered as the measure. The study looked at renewable energy in Kenya. The utilized variables were renewable energy consumption (REC) comprising solar, hydro, wind, geothermal & biomass as independent variable. REC was the independent variable; GDP was the dependent variable and foreign direct investment was the moderating variable. This study derived secondary data from the Kenya National Bureau of Statistics from the year 2002 to the year 2021 for 20 years, 80 quarters.

Kenya set up its long-term development blueprint the vision 2030 which has been implemented and monitored through five-year Medium-Term Plans (MTPs). The third MTP which is the current one for the years 2018 -2022 aims to achieve speedy and inclusive sustainable economic growth, social economic transformation, and development. For the short term, Kenya must start promoting renewable energy sources including wind energy whose production has been very low. In the long-term plan, Kenya has already started the policy developments of the Africa Union Agenda 2063. Agenda one on a flourishing African continent, based on Inclusive Growth and Sustainable Development advocates for Environmentally sustainable and climate-resilient economies and communities and in essence renewable energy. Insaidoo and Amoako (2021) who determined if there is an asymmetric effect of foreign direct investment on energy consumption in Ghana, opine that, by steadily growing the levels of FDI (foreign direct investment) over a period of time, it can aid in minimizing the energy consumption level which would assist Ghana to be on course in achieving the Sustainable Development Goals (SDG), one of which is accomplishing energy efficiency levels by the year 2030. The researchers also used annual time series data on the period 1981 to 2014 period. They found out that energy-saving benefits from foreign direct investment are yet to be obtained in Ghana. Attracting foreign direct investment will aid in establishing renewable energy sources in different parts of Kenya.

The Kenyan Government should ensure there are research and development programs for the energy sector so that alternative energy sources are fully exploited. Innovation will be cultivated in the sector which will attract foreign direct investment into Kenya. Some of the research areas into sources of renewable energy include improvement of storage of renewables, stabilization of power grids, making use of electric vehicles (an initiative that has already been launched by the Kenya Electricity Generating Company PLC (KenGen), concentration on solar power and looking into offshore wind power. The Kenyan president through the ministry of foreign affairs and international trade should ensure that there are no administrative barriers, and no unnecessary regulations, for foreign investments to be administered with ease into the economy. The Kenya Government should ensure that through the Rural Electrification and Renewable Energy Corporation (REREC), they encourage investment in renewable energy infrastructure development, such as subsidies, tax incentives, and grants. These will spur private sector investment in renewable energy projects, create jobs, and stimulate economic activity. The Ministry of Energy must ensure there is renewable energy research and Development Funding by increasing funding for research and development in renewable energy technologies, there will be innovation and technological advancements in the renewable energy sector, driving down costs and improving efficiency, thereby enhancing its contribution to GDP growth. The government of Kenya must ensure there are regulatory support and market mechanisms to facilitate the integration of renewable energy into the energy market. This may include renewable energy targets, feed-in tariffs, net metering policies, and carbon pricing mechanisms, which provide market incentives for renewable energy adoption.

Findings of the research show that an impact on GDP has a permanent impact on foreign direct investment. Mavrotas and Chowdhury (2006) sought to find out if it is FDI that causes GDP or the vice versa from years 1969 to 2000. They concluded that special attention must be accorded to both the quality and overall role of economic growth as this is a vital component of foreign direct investment. In the same breath, for Kenya, the human labour quality, infrastructure, financial institutions, tax regime, governance, ICT, and legal framework among other factors must be enhanced to expand the GDP and consequently increase foreign direct investment. Rand and Hansen (2006) hypothesized Granger causality between foreign direct investment (FDI) and GDP for thirty-one developing countries over a period of thirty-one years. They noted that foreign direct investment has a long-run significant effect on gross domestic product regardless of the level of development in a country. This is the opposite for this study as GDP is the one with a long-run effect to FDI. Soric and Cicak (2015) who also researched on the relationship between FDI and GDP in European economies and made use of the VAR models, surmised that for Slovenia and Latvia there was evidence that GDP causes FDI. This finding corroborated the theory that states that investors are attracted to more stable macroeconomic environments. The president through the ministry of foreign affairs and international trade should ensure that there are no administrative barriers, no unnecessary regulations, in order for foreign investments to be administered with ease into the economy.

References

Abbas, Q., Khan, A.R., Bashir, A., Alemzero, D.A., Sun, H., Iram, R. and Iqbal, N. (2020). Scaling up renewable Energy in Africa: measuring wind energy through econometric approach. *Environmental Science and Pollution Research*, 27 (29) 36282 - 36294.

AfDB/OECD (2020). *African Economic Outlook 2020.* Retrieved from https://www.afdb.org/sites/default/files/documents/publications/afdb20-04_aeo_supplement_full_report_for_web_0705.pdf

Akhtar H., Syed M. A. and Muhammad A. (2017). Emerging renewable and sustainable energy technologies: state of the art, Renewable Sustainable Energy Reviews, 71, 12–28.

Bain, R.L., Amos, W. A., Downing, M. and Perlack, R. L. (2003). Biopower technical assessment: State of the industry and technology. *National Renewable Energy Laboratory*

Barbier, E. (2002). Geothermal energy technology and current status: An overview. *Renewable and Sustainable Energy Reviews*, 6, 3–65. doi: http://dx.doi.org/10.1016/S1364-0321(02)00002-3

Boehlert, G.W. and Gill, A.B. (2010). Environmental and ecological effects of ocean renewable energy development. *Oceanography,* 23(2), 68–81.

Callen, T. (2020). Gross Domestic Product: An Economy's All. Retrieved from https://www.imf.org/external/pubs/ft/fandd/basics/gdp.htm.

Chowdhury, A., and Mavrotas, G. (2006). FDI and Growth: What Causes what? *The World Economy,* 29 (1), 9-19.

Cicak, K., and Soric, P., (2015). The Interrelationship of FDI and GDP in European Transition Countries. *International Journal of Management Science and Business Administration*, 1(4), 41-58.

Demirbas A. (2006). Global renewable energy resources. *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 28(8), 779–792.

Duce, M. (2003). Definitions of Foreign Direct Investment (FDI). A Methodological Note. Banco de Espana. doi: https://www.bis.org/publ/cgfs22bde3.pdf

Dunne, R. and Asaly, R., 2005. Country Report: Kenya. [Online]. doi: /http:// www-personal.umich.edu/kathrynd/kenya.2005.pdfS [assessed: 12/01/07].

Fernandes, A.M. and Paunov, C. (2012). Foreign Direct Investment in Services and Manufacturing Productivity: Evidence for Chile. *Journal of Development Economics*, 97 (2), 305–321.

Fthenakis, V. and Chul, H. (2010). Life-cycle uses of water in U.S. electricity generation Renew. *Sustainable Energy Reviews*, 14, 2039.

George, D., and Mallery, P. (2016). *IBM SPSS Statistics 23 Step by Step: A Simple Guide and Reference* (13th ed.). New York: Routledge.

Glasure, Y.U. and Lee, A. (1997). Cointegration, error correction and the relationship between GDP and energy: the case of South Korea and Singapore. *Energy Economics*, 20, 17–25.

GuechHeang, L., and Moolio, P. (2013). The relationship between gross domestic product and foreign direct investment: The case of cambodia. *KASBIT Business Journal*, 6 (1), 87–99.
Hansen, H., and Rand, J. (2006). On the causal links between FDI and growth in developing countries. *The World Economy*, 29 (1), 21─41.

Hermes, N. and Lensink, R. (2003). Foreign Direct Investment, Financial Development and Economic Growth. *The Journal of Development Studies,* 40 (1), 142–163.

Insaidoo, M., Arthur, L., Amoako, S., and Andoh, F.K. (2021). Stock market performance and COVID-19 pandemic: evidence from a developing economy. *Journal of Chinese Economic and Foreign Trade Studies, ahead-of-p(ahead-of-print).*

Jensen, V. (1996). The pollution haven hypothesis and the industrial flight hypothesis: Some perspectives on theory and empirics. *Working Paper No.5, Centre for Development and the Environment, University of Oslo.*

Khandker, L.L., Amin, S.B., and Khan, F. (2018). Renewable energy consumption and foreign direct investment. *Reports from Bangladesh J. Account,* 8, 72–87.

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

Lehmann, M., Karimpour, F., Goudey, C.A., Jacobson, P.T. and Alam, M.-R. (2017). Ocean wave energy in the United States: Current status and future perspectives. *Renewable and sustainable energy reviews*, 74, 1300-1313.

Lund, J.W. and Freeston, D.H. (2001). World-wide direct uses of geothermal energy 2000. *Geothermics*, 30, 29-68.

Masih, A.M. and Masih, R. (1996). Energy consumption, real income and temporal causality: results from a multi-country study based on co-integration and error-correction modelling techniques. *Energy economics,* 18(3), 165-183.

Muneer, T., Maubleu, S. and Asif, M. (2006). Prospects of solar water heating for textile industry in Pakistan. Renewable Sustainable Energy Reviews, 10(1), 1–23.

Nyamwenga, M. (2009). Foreign Direct Investment in Kenya: A case study in Kenya, *MPRA Paper* No. 34155.Online at https://mpra.ub.uni-muenchen.de/34155/ MPRA Paper No. 34155, posted 17 Oct 2011 06:40 UTC

Obeng, G.Y. and Evers, H.D. (2009). Impacts of public solar PV electrification on rural micro-enterprises: The case of Ghana. *Energy for Sustainable Development*, 14, 223–231.

Onuonga, S. (2012), The Relationship Between Commercial Energy Consumption and Gross Domestic Income in Kenya. *The Journal of Developing Areas*, 46 (1), 305-314 doi: 10.1353/jda.2012.0022

Rafique, M.M. and Rehman S. (2017). National energy scenario of Pakistan–Current status, future alternatives, and institutional infrastructure: An overview. *Renewable and Sustainable Energy Reviews*, 69, 156-167.

Reiter, S.L. and Steensma. H.K. (2010). Human Development and Foreign Direct Investment in Developing Countries: The Influence of FDI Policy and Corruption. *World Development,* 38 (12), 1678–1691.

Rennkamp, B., Haunss, S., Wongsa, K., Ortega, A., and Casamadrid, E. (2017). Competing coalitions: The politics of renewable energy and fossil fuels in Mexico, South Africa and Thailand. *Energy Research and Social Science,* 34, 214–223. doi: https://doi.org/10.1016/j.erss.2017.07.012

Semboja, H. H. H. (1994). The effects of an increase in energy efficiency on the Kenyan economy. *Energy policy*, 218 – 225.

Siddique, H. M. A., and Majeed, M. T. (2015). Energy Consumption, Economic Growth, Trade and Financial Development Nexus in South Asia. *Pakistan Journal of Commerce and Social Sciences*, 9(2), 658-682.

Solangi, K.H., Islam, M.R., Saidura, R., Rahim, N.A. and Fayazb, H. (2011). A review on global solar energy policy. Renewable Sustainable Energy Reviews, 15, 2149–2163.

Stacey, F.D. and Loper, D.E. (1988). Thermal history of the Earth: a corollary concerning non-linear mantle rheology. *Physics of the Earth and Planetary Interiors*, 53, 167 – 174.

Stetson N., and Wieliczko, M. (2020). Hydrogen technologies for energy storage: A perspective. MRS Energy Sustainability, 43:1–9. doi: https://doi.org/10.1557/mre.2020.43.

Suharsono, A., Aziza, A. and Pramesti, W. (2017). Comparison of Vector Autoregressive (VAR) and Vector Error Correction Models (VECM) for Index of ASEAN Stock Price. In AIP Conference Proceedings; AIP Publishing LLC: New York, NY, USA.

Timilsina, G., Kurdgelashvili, L. and Narbel, P. (2011). A review of solar energy: markets, economics and policies. *The World Bank Development Research Group, Environment and Energy Team.*

Ting, Y., Yin, L.R., and Yin, R. (2011). Analysis of the FDI Effect on Energy Consumption Intensity in Jiangsu Province. *Energy procedia*. doi:10.1016/j.egypro.2011.03.019

UNCTAD (1999). *World Investment Report, Foreign Direct Investment and the Challenge of Development,* UN, New York, Geneva.

Vosooghzadeh, B. (2020). Introducing energy consumption theory and its positive impact on the economy. doi: https://searchcio.techtarget.com/defnition/incremental-innovation. Accessed September 2021.

Zhang, K. H. (2001). Does Foreign Direct Investment Promote Economic Growth? Evidence from East Asia and Latin America. *Contemporary Economic Policy*, 19, 2, 175–85.