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The Impact of Renewable Energy Development on Saudi Arabia's Economic Growth

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ABSTRACT
This study aims to identify the impact of renewable energy consumption on economic growth in Saudi Arabia. In this study, we used a quantitative approach with the autoregressive distributed lags bound test for cointegration and a related error correction model to analyze the data. The data were collected from the World Bank, covering the period from 1990 to 2021. An analysis of the study employed a set of variables, in which renewable energy consumption, carbon dioxide emissions, and trade are considered as independent variables, and the dependent variable is GDP per capita. The results showed that renewable energy consumption has an adverse and insignificant impact on economic growth in Saudi Arabia in the short-term relationship. In the long run, however, it has a positive, statistically significant effect on economic growth. The current study suggests the modification of the regulations governing renewable energy sources in order to achieve significant and favorable short-term economic growth. Additionally, the Kingdom of Saudi Arabia Vision Plan 2030 will continue to be implemented, and through it, the National Renewable Energy Program will effectively support the Kingdom's economy, develop its human resources, and encourage investments from both international and domestic businesses.

INTRODUCTION
Global economic activity is fueled by energy. By 2030, it is anticipated that total energy demand will increase by 21% as a result of growing populations, rising living standards, and increased consumption. At the same time, governments all over the world are looking for ways to provide energy while reducing greenhouse gas emissions and other environmental effects due to increasing concerns over climate change. Investment and infrastructure decisions made today in the energy sector will lock in associated costs and benefits for at least a few decades. They also have an important effect on how well the energy sector supports overall economic growth (IRENA, 2016). Investment in renewable energy has received significant attention in recent years on a global scale in an effort to achieve sustainable economic, social, and environmental development policies. From job creation to resource efficiency and the environment, the energy industry affects the health and sustainability of the whole economy. Significant changes in the industry can have a substantial impact on the entire economy. As a result, there is a strong link between energy use and development (Safa, 2017). The Industrial Revolution witnessed a significant shift in manufacturing technology away from manual labor and toward machines, as well as an increase in the use of coal burning to produce steam. Numerous studies have found a strong positive correlation between the demand for energy and global growth. More precisely, when compared to other Middle Eastern nations, Saudi Arabia has the greatest energy usage (Krane, 2019). By the end of 2019, the Kingdom of Saudi Arabia's average oil

consumption was 4.3 million barrels per day (bpd), up from an average of 4.1 million bpd in 2018 (SME, 2020). By the end of 2018, Saudi Arabia had consumed about 289.9 terawatt hours, a 0.42% increase over the previous year. According to (Rambo, 2017), the primary factor contributing to the significant growth of the non-oil sector is the consistent annual growth rate of 4.5% between 2010 and 2019. Additionally, a fertility rate of 3.2% per year from 2012 to 2017 has also played a role in this growth. Another influential factor is the extensive use of water desalination, which has resulted in high domestic energy consumption in the region. According to (Negewo et al., 2012), it will take about 8 million bpd of oil production to meet domestic energy demand by 2050. This high level of domestic energy use should limit the Saudi government's capacity to export more oil barrels in the short term. As a result, it is essential for the Saudi government to exert control over rising domestic energy consumption. For Saudi Arabia, using renewable energy as a supplement to its current energy sources could ease the country's dependence on fossil fuels. Several renewable energy projects are being carried out in the area, all of which are helping to grow local businesses. Furthermore, if carbon emissions are reduced in the regional economy, Saudi Arabia could make a greater contribution to the fight against climate change. Since the Saudi government spends substantially on healthcare, keeping its citizens healthy can save money. Investing in renewable energy can help Saudi Arabia's economy become one that is dynamic, sustainable, and stable (Negewo, 2012). The development of renewable energy sources and investment in renewable energy have been priorities for Saudi Arabia during the past few years. A renewable and sustainable energy supply of 9.5 GW is the goal set forth in Saudi Vision 2030 for the year 2030. By 2030, Saudi Arabia intends to raise the number of investments in this industry by 40 billion dollars, including 30 billion for renewable energy sources (EIA, 2019). This is to achieve these goals. By giving renewable energies a larger share of the energy consumed—rising from 42% in 2020 to 52% in 2030—it also aims to change the composition of the energy used. Although Saudi Arabia does not have a dedicated framework for renewable energy investment, the Saudi government has established a number of steps to encourage investment in the sector. It has significant potential for renewable energy sources, but there is little scientific study that examines and analyzes the Saudi renewable energy sector in all aspects that may impact the economy. In addition, choosing the best investment scenario in Saudi Arabia for the foreseeable future is challenging, despite the potential availability of a variety of renewable energy investment scenarios and alternatives. Furthermore, knowledge of all the essential factors considered in the transition to fully renewable energy sources remains limited. As a result, there is a rising need for national research on renewable energy sources

RESEARCH OBJECTIVES

Study area

RESEARCH QUESTION

"How does the consumption of renewable energy affect economic growth in Saudi Arabia?"

The question raised by our research in the area of renewable energy and its role in achieving a sustainable economy is that there is an increasing demand for energy in the face of dependence on fossil fuels, which are in danger of being exhausted, and due to harmful emissions, without taking into account an environmentally sustainable economy and its unsustainability, raises research questions on renewable energy sources and their relationship to economic growth.

THE IMPORTANCE OF THE STUDY

Energy plays the role of a driver of economic activity, and it is demonstrated by the important and growing role that energy plays in all the world's economies, whether in developed or developing countries alike, whether oil or non-oil and whether renewable or non-renewable. Increasing economic activity in order to achieve positive economic growth requires an increase in energy consumption, and achieving sustainable economic growth requires the provision of renewable, sustainable and guaranteed energy supplies. For this reason, all countries of the world are seeking to provide these energy supplies and thus develop energy policies in the medium and long term, whose goal is to secure their energy requirements, including ensuring their energy security (Kraft, 1978). Hence, the importance of the effective role that the development of infrastructure can play in the path of transformation towards a renewable energy economy as one of the basic pillars for advancing economic growth. The importance of the study lies in the fact that it addresses one of the most frequently discussed topics among economic researchers by searching for the accuracy of the relationship that exists between the consumption of renewable electrical energy and economic growth, especially in light of the fluctuations in traditional energy prices on the one hand and the negative effects of the latter on the environment on the other hand. The results will give some guidance on what exists in the literature on the nature of the relationship, which will help **policymakers** in developing appropriate energy **policies** and **determining** the optimal methods to achieve the best possible economic benefit. On the other hand, it is considered an important economic issue, as its importance lies in the necessity of investing in the field of renewable energies in order to achieve economic growth. The importance of this study is also highlighted by examining the role that renewable electrical energy plays in stimulating economic growth and the effects resulting from the nature of this relationship. Despite the many studies related to the issue of consumption of renewable energies in developed and developing countries, which in itself shows the importance of this study, this study is important in choosing a country that relies heavily on oil exports, which makes it vulnerable to price fluctuations and thus the impact on energy. In addition, its contribution to greenhouse gas emissions **is notable**. Most important of all, the Kingdom of Saudi Arabia launched the 2030 Vision for Sustainable Development, which aims to transform its economy from an oil-dependent economy to a diversified, innovative and competitive economy. Vision 2030 includes a special clause related to the renewable energy market. This clause aims to increase the volume of renewable energy production by 50% by 2030, with a focus on solar and wind energy (SME, 2021)**,** which makes this study a valuable addition to an accurate and clear understanding of the relationship between renewable energy consumption and economic growth, as well as its economic dimensions in the Kingdom of Saudi Arabia.

LITERATURE REVIEW

There are many studies that have dealt with topics related to renewable energies, and below we will list some of them: (Mankiw, 2007) states that economic growth represents a nation's national output, which determines the rate of change in its standard of living. In reality, one of the primary objectives for national development in underdeveloped countries may be a high rate of economic growth. It is possible to detect a direct correlation between economic expansion and the rise in social production of products and services. An increase in production of products and services could boost social well-being.

(Niu et al., 2013) examined the link between energy use and human development.

They used panel data for 15 countries. They also selected human development, GDP per capita and urbanization rate. The research results show that there is a long-term two-way causal relationship between electricity consumption and the five indicators. The report also recommends integrating electricity into basic public services and improving access to electricity for low-income groups, thus promoting human development.

(Belaid & Youssef, 2017) investigated the relationship between environmental issues, the use of all energy sources, and Algeria's economic development. The research made use of data from 1980 to 2012. The Granger causality test and an autoregressive distributed lag model were both utilized in the study to analyze the data and determine the connection between the variables in Algeria. The outcomes demonstrated long-term unidirectional causality. Renewable energy could be a key driver of economic growth and job creation in Algeria, according to the research.
Renewable energy and economic development nexus were the subject of (Khobai, 2018)'s study. The data examined in the study included the years 1997 to 2012. In order to analyze the data, the study utilized Granger causality tests and a VAR model. The study's results revealed that there is a causal relationship between economic development and electricity and the usage or the production of renewable energy actually increases economic growth. As a result, the author's recommendation was that the South African government take proactive measures to adopt energy policies that do not impede economic growth.

Using the Canning and Pedroni long-term causality test, (Apergis and Danuletiu, 2014) studied the relationship between the usage of renewable energy and economic growth for 80 nations. For the entire sample as well as for the various areas, the two authors demonstrated the presence of a long-term positive causation between renewable energies and real GDP. The link between the consumption of renewable energy and economic expansion suggests that renewable energy is crucial for both economic development and environmental quality. In the same vein,

According to (Tiba and Omri, 2017), IRENA (International Renewable Energy Agency), KSA could utilize 25% less fossil fuels in the electricity and water sectors by 2030. The Saudi Aramco Oil Company owns the largest solar installation in the world, which is located on KSA's parking lot. Since this occurrence, the KSA has diversified its economy and promoted development by investing in Renewable Energy Sources (RnSE), altering its domestic power structure, and projecting a global energy leadership image. One of the environmental advantages of the greater accessibility of Renewable Energy resources is the preservation of a clean environment. These elements lead to an increase in employment vacancies, a decrease in the trade imbalance, and a reduction in greenhouse gas emissions. For instance, in 2008, the average global market rate for a comparable GCC utility was 50.4 SAR/kWh, however, Saudi government subsidies resulted in an overall cost for the KSA of just 0.15 SAR/kWh. However, the price of solar energy has dropped from US $101/kWh to about US.
More recently, (Saidi and Omri, 2020) utilized the vector error correction model estimate and ordinary least squares approaches to investigate how well renewable energy promoted economic growth and decreased CO_2 emissions in the case of 15 countries. According to the findings, there is both a short- and long-term causal association between economic growth and renewable energy.

Finally, we cite (Bilan et al., 2019)'s research. The authors studied to see how a nation's gross domestic product is affected by its usage of renewable energy sources, CO2 emissions, macroeconomics, and political stability. RES, like people and capital resources, has an effect on GDP for EU nations. The findings also show that the correction retracts as economic expansion raises the use of renewable energy sources. Finally, the research shows that nations that are candidates for membership in the EU and those that might be candidates should support the growth of renewable energy. Finally, the research shows that nations that are candidates for membership in the EU and those that might be candidates should support the growth of renewable energy.

METHODOLOGY

In this part, we will discuss measuring the impact of renewable energy consumption on economic growth by using standard and statistical performance in the applied study. This study is quantitative research that makes use of time series data acquired from the World Bank (WDI, 2021), that covers the years 1990 to 2021, using renewable energy consumption, carbon dioxide emissions and trade as the control variables.

Table 1 presents the description and measurement of all variables for this study.

Symbol	Variable	Description	Unit
GDP	GDP per capita	Gross domestic product per capita.	constant 2015 US$
REC	Renewable Energy Consumption	Renewable energy consumption is the share of renewable energy in total final energy consumption.	% of total final energy consumption
Co2	Carbon dioxide emissions	Carbon dioxide emissions from all sources	Metric tons
TR	Trade	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.	% of GDP

The study will analyze the chosen variables, renewable energy consumption and economic growth in KSA, using the E-Views program, with an autoregressive distributed lags bound test for cointegration and a related error correction model. To do this, we use GDP as the dependent indicator and we start from the following relationship: The linear econometric model can be written as in equation 3:

Whereby,
Dependent variable:
Log (GDP)= Natural logarithm of gross domestic product per capita
Independent Variables:
REC= Renewable Energy Consumption, TR= Exports and Imports, Co2= CO2 emissions
€ = Error term, t= period, β0-3= Constants

UNIT ROOT

Before implementing the autoregressive distributed lags (ARDL) model, tests of the unit root are first estimated. If the variables are discovered to be stationary, this is done to ascertain the degree of integration of the variables and prevent issues with misleading regressions. We utilize the Augmented Dickey-Fuller test at the level and at the first difference to examine the stationarity of the data. In each test, the alternative hypothesis of stationarity is compared against the null hypothesis of a unit root. The null hypothesis of a unit root is rejected, and the conclusion is drawn that the series is stationary if the computed ADF test statistic is greater than the critical values at the 1%, 5%, and 10% levels of significance (Dickey, D., Fuller, W., 1979). The properties of all the variables included in the perspective model are examined in this study. When the data is determined to be stationary, it means that its variance, mean, and covariance remain constant throughout time. The analysis's findings are trustworthy, and the results can be used to predict the economy's future growth.

AUTOREGRESSIVE DISTRIBUTED LAGS MODEL AND LONG RUN TEST

The study examines the consumption of renewable energy and the growth of the Saudi economy using the Autoregressive Distributed Lags model put forth by (Pesaran et al., 2001). Only a few studies in KSA have examined the topic in depth, but this study employs this model to test the short- and long-term correlations between the dependent variable and the independent one, and to check the consistency of the results from the research in the literature section. The model for both short-term and long-term relationships can be expressed as follows, as illustrated in Equation 3.2 below:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots\ldots + \alpha_p y_{t-m} + \beta_0 x_t + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \ldots\ldots\ldots + \beta_q x_{t-n} + \varepsilon_t \qquad 3.2$$

m and n= the numbers of years, ε_t=Error term, α_i= coefficients for short-run and β = coefficients for long-run relationship and i = is the indicator of the lag. The ARDL model for long run relationships can be specified as given in Equations 3.2.1 to 3.2.4 below:

$$LGDP = \beta_{01} + \sum_{i=1}^{p} k_{11} LGDP_{t-i} + \sum_{i=1}^{q} k_{21} REC_{t-i} + \sum_{i=1}^{q} k_{31} Co2_{t-i} + \sum_{i=1}^{q} k_{41} trade_{t-i} + \varepsilon_t \qquad 3.2.1$$

$$REC = \beta_{02} + \sum_{i=1}^{p} k_{12} REC_{t-i} + \sum_{i=1}^{q} k_{22} LGDP_{t-i} + \sum_{i=1}^{q} k_{32} Co2_{t-i} + \sum_{i=1}^{q} k_{42} trade_{t-i} + \varepsilon_t \qquad 3.2.2$$

$$Co2 = \beta_{03} + \sum_{i=1}^{p} k_{13} Co2_{t-i} + \sum_{i=1}^{q} k_{23} REC_{t-i} + \sum_{i=1}^{q} k_{33} LGDP_{t-i} + \sum_{i=1}^{q} k_{43} trade_{t-i} + \varepsilon_t \qquad 3.2.3$$

$$Trade = \beta_{04} + \sum_{i=1}^{p} k_{14} trade_{t-i} + \sum_{i=1}^{q} k_{24} REC_{t-i} + \sum_{i=1}^{q} k_{34} Co2_{t-i} + \sum_{i=1}^{q} k_{44} LGDP_{t-i} + \varepsilon_t \qquad 3.2.4$$

ARDL- ECM (ERROR CORRECTION MODEL) AND SHORT RUN TEST

This paper utilizes the ECM model to analyze the short-term relationships between the variables after confirming the end of a long-term relationship through the bounding test. By employing a simple linear transformation, a short error correction model can be derived from the main ARDL model. This ARDL-ECM model is represented by equation 3.3, where the term enclosed in brackets, ECTt-1, serves as the error correction term. It is expected to have a negative value and be statistically significant, indicating the adjusted differences in the short-term variables and representing the coefficient of the speed at which the system adjusts towards long-run equilibrium. The model is expressed as follows in equation 3.3:

Variables	t-statistic	1% value	5% value	10% value	P- value
GDP	-5.536045	-3.67017	-2.963972	-2.621007	0.0001
REC	-4.40658	-3.679322	-2.967767	-2.622989	0.0016
Co2	-3.66325	-3.67017	-2.963972	-2.621007	0.0102
Trade	-4.339803	-3.67017	-2.963972	-2.621007	0.0019

$$Yt=a0+b1Xt+\pi(ECTt-1) + \varepsilon t \qquad 3.3$$

DIAGNOSTICS TEST

Serial correlation

The Breusch-Godfrey Serial Correlation test will be used in the study to identify serial correlation in the model.

Heteroskedasticity

The Breusch-Pagan-Godfrey test will be used in the study to determine whether or not the estimated model meets the homoscedasticity requirement.

Normality test

To determine if the residuals of the estimated model are normally distributed and to ensure that the normality criterion of linear models has not been violated and Jarque-Berra histogram normality test will be used.

Stability tests

In order to ensure the stability of the estimated coefficients, this research paper will employ the CUSUM SUM plus Ramsey RESET tests to assess the validity of the model.

RESULTS & DISCUSSIONS

As shown in Table 2 of the study, the ADF unit root test was run. According to the test results in Table 2, all of the variables are integrated of I(1) and stationary at the first difference. However, to perform a better analysis, the study will utilize variables in their first difference form to estimate the associations, which makes the ARDL model suitable for analysis

Table (2): ADF unit root test at first difference.

Statistic	GDP	REC	CO2	TRADE
Mean	18407.57	1.677568	13.38825	71.85987
Median	18195.46	1	13.06912	68.99882

Maximum	20508.12	5	17.25783	96.10264
Minimum	15561.48	0.933233	10.70976	52.07659
Std. Dev.	1288.82	1.134389	2.062511	11.41821
Skewness	-0.129334	1.477203	0.335762	0.441083
Kurtosis	2.15949	4.007958	1.730062	2.286758
Jarque-Bera	1.031156	12.99266	2.751582	1.715907
Probability	0.597155	0.001509	0.25264	0.424029
Sum	589042.3	53.68219	428.4239	2299.516
Sum Sq. Dev.	51492749	39.892	131.8725	4087.006

Table 2 shows the descriptive statistics for the variables chosen to provide an overall understanding. The GDP per capita is on average 18,407.57 US, with a maximum value of 20,508.12 US$. Renewable energy consumption ranges between 0.9% and 5% of total final energy consumption. Trade ranges between 52.07% and 96.10%. CO2 ranges from 10.7% to 17.25%. The series of GDP is negatively skewed, and positively skewed for all other variables. Based on the kurtosis test, all variables are less than 3, which means they are Platykurtic curves, except for renewable energy consumption, where the kurtosis is larger than 3, which means it is a Leptokurtic curve. Except for renewable energy consumption, regarding the normality test, the outcome of the study's Jarque-Bera shows that the residuals are distributed properly.

All the variables are integrated at the first difference according to the unit root results, and the E-Views program automatically determines the ideal lag length criterion to apply in the study, as shown in Figure 1. According to the AIC criteria, the results demonstrate that the lag can be used to estimate both short- and long-term associations. As demonstrated in Table 4, by utilizing the ARDL Bounds test, the study will continue to examine the cointegration relationships

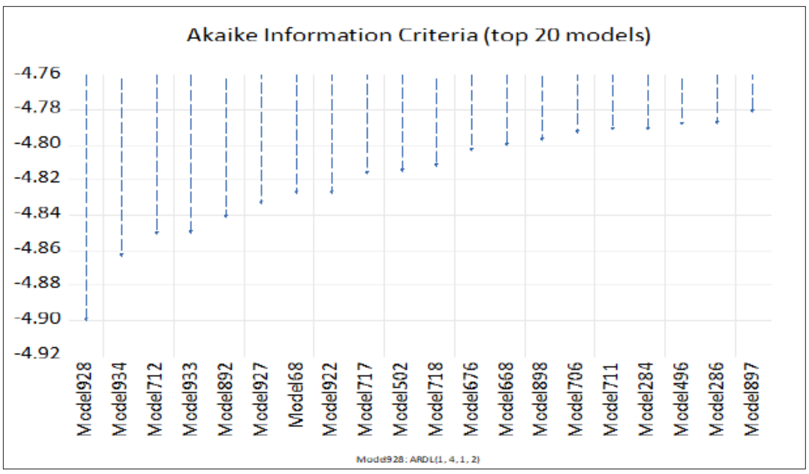


Figure (1): Optimal lag length criterion (AIC)

The results of the test for cointegration were used in the study to check for long-term correlations between the model's variables, as demonstrated in Table 4. The f-statistic is 12.66503, which is above the thresholds for significance at all levels. This suggests that we reject the null hypothesis (H_0) that there are no long-term relationships among the variables and come to the conclusion that there are long-term relationships. Equations 3.2.1 to 3.3 from the study above will be used to evaluate both the short- and long-term relationships.

Table (4): Bounding test to cointegration.

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	12.66503	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Upon conducting the short-run test, as depicted in Table 5, it becomes evident that there is a negative relationship between renewable energy consumption and the dependent variable (economic growth) in Saudi Arabia. Specifically, a 1% increase in the independent variable (renewable electricity consumption) in the short run has an insignificant impact on economic growth, leading to a decline of 124% while considering other factors unchanged. These results suggest that the utilization of renewable energy has not been successful in expediting short-term economic growth. As a result, policymakers and governments in Saudi Arabia are urged to revise regulations pertaining to the use of renewable energy sources with the aim of promoting and accelerating economic growth in the short term.

Table (5): Short run relationships

ARDL Error Correction Regression
Dependent Variable: DLOG(GDP)
Selected Model: ARDL(1, 4, 1, 2)
Case 2: Restricted Constant and No Trend
Date: 06/14/23 Time: 20:53
Sample: 1990 2021
Included observations: 28

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(REC)	-1.240117	0.681035	-1.820929	0.0874
D(REC(-1))	-8.166159	1.192889	-6.845701	0.0000
D(REC(-2))	-7.044470	0.925744	-7.609525	0.0000
D(REC(-3))	-4.096272	1.016300	-4.030573	0.0010
D(CO2)	0.026439	0.006761	3.910647	0.0012
D(TRADE)	0.003058	0.000565	5.414960	0.0001
D(TRADE(-1))	0.004960	0.000892	5.557430	0.0000
CointEq(-1)*	-0.849565	0.095489	-8.896990	0.0000

R-squared	0.863958	Mean dependent var	-6.14E-05
Adjusted R-squared	0.816343	S.D. dependent var	0.037083
S.E. of regression	0.015892	Akaike info criterion	-5.211049
Sum squared resid	0.005051	Schwarz criterion	-4.830419
Log likelihood	80.95469	Hannan-Quinn criter.	-5.094687
Durbin-Watson stat	1.951042		

* p-value incompatible with t-Bounds distribution.

The findings also show a short-term positive and significant correlation between the second variable, which is carbon dioxide, and the dependent variable (economic growth). In the short run, a 1% rise in carbon dioxide emissions causes economic growth to increase by 2.64%, ceteris paribus. These findings show that Saudi Arabia's economic growth depends on the use of fossil fuels and non-renewable electricity sources. This suggests that the government reconsider its CO2 emission regulations, aiming to lessen the country's reliance on fossil fuels and the harm that air pollution does to the environment. Furthermore, a relationship between the last variable, trade, and short-term economic growth has been found. Ceteris paribus, a 1% rise in trade will significantly lead to an increase in economic growth of 0.30%. Table 5 shows that the value of R-squared is 0.8639, meaning that the independent variables account for 86.39% of the variation in the model, while the error term accounts for the remaining 13.61%. This outcome demonstrates the model's goodness of fit, which should be 70% or higher for a trustworthy model, as is strongly advised.

Additionally, Table 5 shows that the ECT term has a statistically significant value of -0.849565, which suggests that 85% of the error in the dependent variable is corrected annually towards long-run equilibrium. Long-term relationships continue to be examined in the study, as seen in Table 6. According to the findings in Table 6, the study evaluated long-term relationships. The findings show that the consumption of renewable electricity and economic growth are positively correlated and statistically significant. Long-term economic growth will rise by 758%, ceteris paribus, for every 1% increase in the consumption of clean energy. This outcome implies that the usage of renewable energy is significant for Saudi Arabia's economic growth. Furthermore, according to the findings presented in Table 6, a significant long-term relationship exists between CO2 emissions and economic growth. Specifically, for each 1% increase in CO2 emissions, economic growth in Saudi Arabia rises by 5.34%, all other factors held constant. This result suggests that CO2 emissions are playing a role in stimulating economic growth within the country. Consequently, the government has a responsibility to align its policies and actions regarding CO2 emissions with the objective of fostering economic growth. Moreover, there is a long-term inverse relationship between the independent variable (trade) and Saudi Arabia's economic growth. Long-term economic growth will decline by 0.1624% for every 1% rise in trade, ceteris paribus. To be able to increase economic growth, the government must evaluate and change its trade policy.

Table (6): Diagnostic tests.

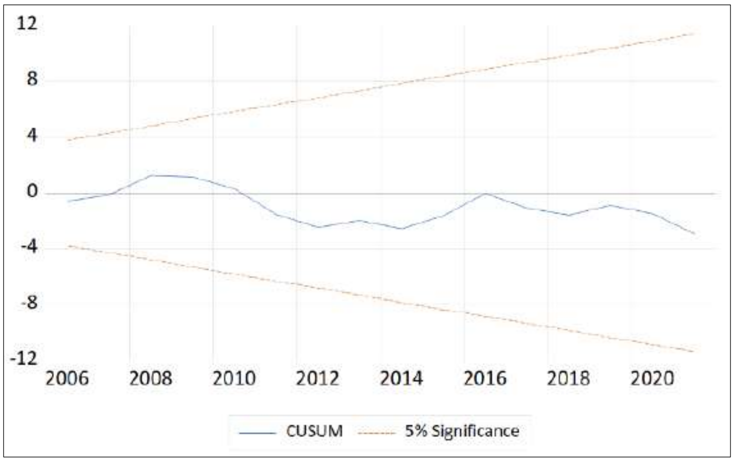
Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REC	7.585044	0.972276	7.801329	0.0000
CO2	0.053401	0.005228	10.21397	0.0000
TRADE	-0.001624	0.000652	-2.492922	0.0240
C	10.45056	0.062321	167.6902	0.0000

EC = LOG(GDP) - (7.5850*REC + 0.0534*CO2 -0.0016*TRADE + 10.4506)

RESIDUAL DIAGNOSTICS TEST

According to Table 7 below, several diagnostic tests have been performed. Based on the findings, there is neither correlation nor heteroskedasticity in the model we selected. In addition, regarding the normality test, the outcome of the study's Jarque-Bera test shows that the residuals are distributed properly. Finally, the model is appropriately specified, according to the results of the study's Ramsey's RESET test for misspecification.



CONCLUSION

The study examines the relationship between Saudi Arabia's economic growth from 1990 to 2021 and the consumption of renewable energy. In order to control the order of integration and prevent the issue of misleading regressions, the Augmented Dickey-Fuller unit root test was used in the study. The ARDL Bounds test was used in the study, which discovered cointegration relationships between the variables. To test for short- and long-term relationships between the model's variables, the study used the ARDL model. Therefore, based on actual data, the report recommends the following policies:

First and foremost, the Saudi Arabian government needs to reform its laws regarding the use of renewable energy sources and the disclosure method. Thus, in the short term, it may be able to dramatically and favorably improve economic growth. Additionally, by hastening the process of renewable energy adoption, which has significant long-term effects, the country can diversify its economy, reduce its dependence on oil revenues, and create new opportunities for economic growth. This shift can lead to the development of new industries, job creation, and increased foreign investment.

Secondly, economic growth has been proven to be boosted by carbon dioxide, and it is a short-term economic benefit. However, it is crucial for policymakers and the government in Saudi Arabia to recognize the long-term risks and consequences associated with heavy reliance on fossil fuels. By reviewing policies, promoting renewable energy, and embracing a low-carbon economy, Saudi Arabia can mitigate environmental impacts, position itself for future economic success, and contribute to global efforts in addressing climate change.

In the long term, it is advisable for Saudi Arabia to re-evaluate its trade policies, as they could pose a threat to the growth of their economy. This could be achieved by establishing a congenial setting that encourages the promotion of exports and the diversification of the economy. Additionally, the country can improve its competitiveness by attracting foreign direct investment, increasing market access, and fostering the growth of strategic industries.

The primary aim of the research was to examine the relationship between the consumption of renewable energy and the economic growth of Saudi Arabia. To achieve this objective, the study utilized an Autoregressive Distributed Lags (ARDL) model to demonstrate both short- and long-term relationships. After thorough analysis, it was determined that although renewable energy usage exhibited a negative, yet insignificant, short-term relationship, it had a positive long-term relationship. To gain further understanding, future studies should consider alternative models and incorporate additional observations to gain new perspectives.

The analysis uses time-series data obtained from the World Bank for the period 1990 to 2021. One of the primary challenges in researching the contribution of renewable energy to economic growth is the reliance on specific models or procedures that may not be suitable for generalizing the results across different contexts. Furthermore, there are relatively few studies that thoroughly examine the relationship between renewable energy, energy efficiency, and their collective economic impacts. To address this gap, the current study aims to investigate the long-term and short-term dynamics of this relationship. The study employs the Augmented Dickey-Fuller (ADF) unit root test, the autoregressive distributed lags (ARDL) bound test, and a related error correction model (ECM) to analyze the data and provide robust insights into the relationship between renewable energy consumption and economic growth in Saudi Arabia.

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